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THESIS

STEMMING THE FLOW OF IMPROVISED EXPLOSIVE DEVICE MAKING MATERIALS THROUGH GLOBAL EXPORT CONTROL REGIMES

by

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September 2012

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The effects of Improvised Explosive Devices (IEDs) continue to be felt throughout the world, and especially in battlefields, such as Afghanistan. The United States currently leads the counter-IED effort through various demand side efforts, such as those led by JIEDDO and Project Global Shield. The purpose of this thesis was to determine the feasibility of a new supply-side effort to counter IEDs through global export control similar to the multilateral export control regimes of Weapons of Mass Destruction (WMD) and missile technologies. A comparative method was used that utilized the existing regime literature for success and effectiveness, and then measured those regimes against six variables that focused on technology, as well as the organizations, which provided the framework to determine the success and feasibility of a new regime that focuses on lower technology items. The results show that although IEDs continue to be a presence throughout the world, it lacks the grander threat similar to that of WMD technology to make a new regime successful. Further, the results show that IED technology and material are difficult to classify and track, which makes global export control efforts extremely difficult.

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LIST OF ACRONYMS AND ABBREVIATIONS

AG	Australia Group
AN	Ammonium Nitrate
ANFO	Ammonium Nitrate Fuel Oil
CITS	Center For International Trade and Security
COCOM	Coordinating Committee For Multilateral Export Controls
CREW	Counter RCIED Electronic Warfare
DHS	Department of Homeland Security
DoD	Department of Defense
DTMF	Dual-Tone Multi-Frequency
EOD	Explosive Ordnance Disposal
EU	European Union
G8	Group of Eight
GAO	Government Accountability Office
GWOT	Global War on Terror
HASC	House Armed Services Committee
HCOC	Hague Code of Conduct
HE	High Explosives
IED	Improvised Explosive Device
INIR	Integrated Nuclear Infrastructure Review
INTERPOL	International Criminal Police Organizations
IRA	Irish Republican Army
ISAF	International Security Assistance Force
JIEDDO	Joint Improvised Explosive Device Defeat Organization
JMTC	Joint Multinational Training Command
JTF	Joint Task Force
MANPADS	Man Portable Air Defense Systems
MERC	Multilateral Export Control Regime
MTCR	Missile Technology Control Regime
NKM	Nuclear Knowledge Management
NSG	Nuclear Suppliers Group
PIR	Passive Infrared
PSI	Proliferation Security Initiative

RCIED	Radio Controlled Improvised Explosive Device
SALW	Small Arms and Light Weapons
START	Study of Terrorism and Response to Terrorism
UN	United Nations
UNODC	United Nations Office on Drugs and Crime
UNSC	United Nations Security Council
WA	Wassenaar Arrangement
WMD	Weapons of Mass Destruction

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I. STEMMING THE FLOW OF IMPROVISED EXPLOSIVE DEVICE MAKING MATERIALS THROUGH GLOBAL EXPORT CONTROL REGIMES

A. MAJOR RESEARCH QUESTION

Improvised Explosive Devices (IEDs) have caused the majority of casualties in the current Global War on Terror (GWOT). The use of IEDs is not a new concept; however, the method in which they are constructed has evolved with technology. With efforts to defeat this device using technological countermeasures and network analysis, it has become apparent that IED and Counter-IED effort has become a race between offense and defense.

The counter-IED effort focuses on the terrorist networks while also training operators to defeat the device. So the question is, what is the feasibility of creating a global export control regime to control IED making materials? Weapons nonproliferation efforts have increasingly focused on technology exports. In an increasingly globalized society, technology exports link factories that produce this material to the most remote areas of the world, including the battlefields of Iraq and Afghanistan. This thesis focuses on the export of IED material to aid the current counter-IED regime. Controlling technology exports may possess the ability to slow or even stop the global IED problem.

B. IMPORTANCE

IEDs are homemade instruments used to cause injury or death using explosives, biological, chemical, or even radiological material and can vary in size.[1] They have become a household name since the start of the GWOT; however, the application of IEDs has a long history. The use of the IED dates back to 1605, when "a radical group attempted to blow up the British Parliament and assassinate King James I."[2] They

[1] U.S. Library of Congress, Congressional Research Service, *Improvised Explosive Devices (IEDs) in Iraq and Afghanistan: Effects and Countermeasures*, by Clay Wilson, CRS Report RS22330 (Washington, DC: Office of Congressional Information and Publishing, 2007).

[2] Joint IED Defeat Organization, *2012–2016 JIEDDO Counter-IED Strategic Plan Released* (Washington, DC: Federal Information & News Dispatch, Inc., 2012).

continued to be used in conflicts throughout the 20th century, with the Vietcong using booby-trapped mines in the Vietnam conflict. Also, the Irish Republican Army was famously known for using sophisticated devices during the conflict in Northern Ireland. Yet, in the last 10 years, the IED has increasingly taken on a new importance, as it has accounted for almost 70 percent of the casualties in both Iraq and Afghanistan.[3] They also continue to be used throughout the world, accounting for over 250 events outside of Iraq and Afghanistan every month.[4]

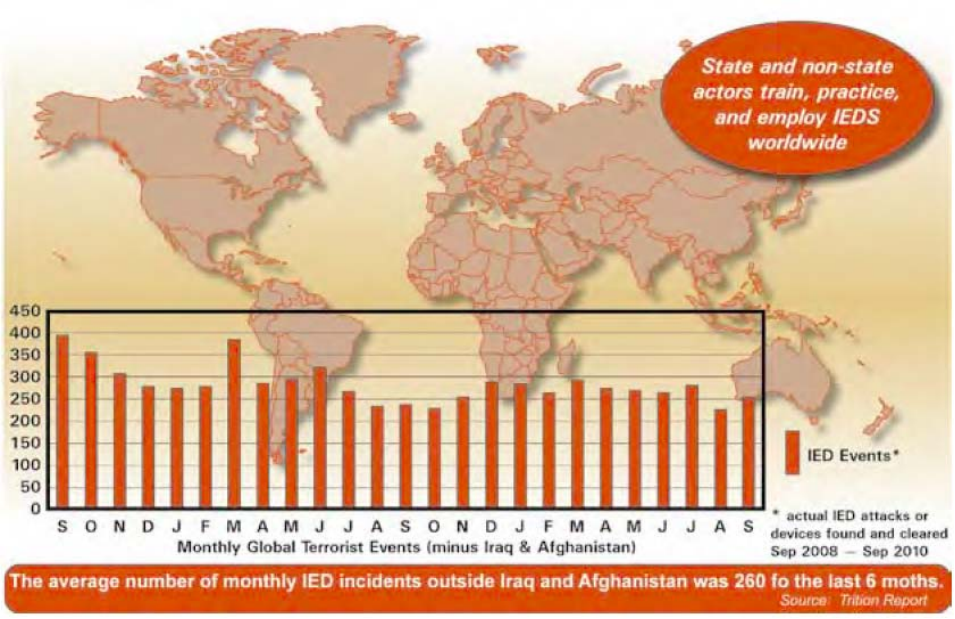

Figure 1. Global IED Events, September 2008–September 2010[5]

Significant IED incidents were recorded in Pakistan, India, Colombia, England and Norway in 2011.[6] The main reason for the high casualty rate is the level of sophistication and inability to detect the devices used, including radio controlled triggering mechanisms and homemade explosive material utilized as the main charges.

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[3] Joint Improvised Explosive Device Defeat Organization, "Annual Report: 2010," Washington, DC: JIEDDO, 2010.

[4] Ibid.

[5] Ibid.

[6] Joint IED Defeat Organization, *2012–2016 JIEDDO Counter-IED Strategic Plan Released*.

The significance of this research question highlights the gap between the upstream and downstream efforts to counter the global IED problem (See Figure 2). Currently, the organization charged with leading the counter-IED effort is the U.S. Department of Defense's (DoD) Joint Improvised Explosive Device Defeat Organization (JIEDDO). Its main effort has been to attack the network of bomb builders, emplacers, trainers and financiers. It also outlines efforts to defeat the device, while also training the force to defeat the devices found.[7] The precepts of JIEDDO's mission do not specifically highlight efforts to combat the supply of the material from the manufacturer to the bomb building and facilitation networks. This gap is the focus of this thesis.

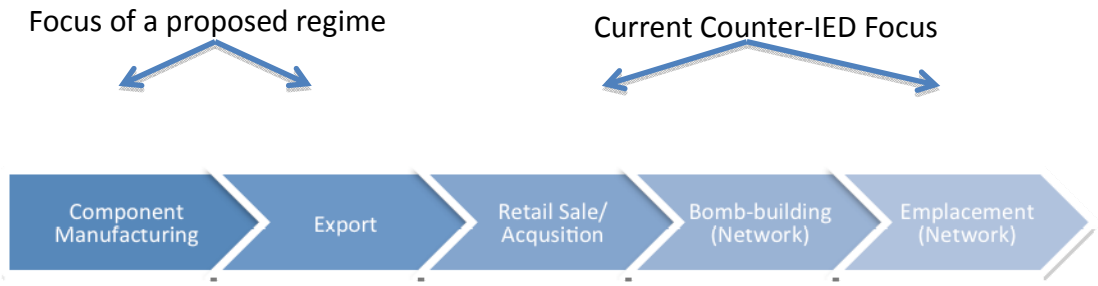

Figure 2. Path of IED Making Material and Efforts to Counter Them

Finally, understanding the current global export and weapons control regimes identifies factors that explain regime effectiveness, which will provide the basis for examination of a new IED control regime. Creating a global regime to control IED making material would provide those combating the effects of the devices on the battlefield a new tool to defeat them. It will decrease the flow right from the source of production and prevent the materials used to create effective IEDs from ever reaching the battlefield.

C. PROBLEMS AND HYPOTHESES

The main issue that this question addresses is the prevention of the export of material used in IEDs from the source of production. A conceptual problem that also

[7] Joint Improvised Explosive Device Defeat Organization, "Annual Report: 2010."

needs to be addressed is the classification of the specific IED making material. As the name suggests, the improvised nature creates problems with identifying what exactly needs to be controlled. One of the contributions of this thesis is to classify the most prevalent and dangerous material that has been used in Iraq, Afghanistan, and throughout the world. To assess the feasibility of such a regime, the technologies in question will need to be classified as dual-use, that is, material that has both a civilian use and a more dangerous military use.[8] Although little consensus exists as to what constitutes material used in IEDs, the author focuses on items that have played a significant role in terrorist bombing actions in Iraq and Afghanistan. The three main components include ammonium nitrate, a nitrate based fertilizer and two electronic triggering mechanisms, the dual-tone multi frequency board and the passive infrared sensor.

To assess the feasibility of a new regime, it is important to examine the existing export control efforts to understand cooperation among Multilateral Export Control Regimes (MERCs). Each of the current MERCs is an ancillary organization to a treaty or convention that attempt to control the individual technologies in question. To understand the background of export control regimes, the author reviews the Nuclear Suppliers Group (NSG), the Australia Group (AG), the Missile Technology Control Regime (MTCR) and the Wassenaar Arrangement (WA). He also uses the efforts of United Nations Security Council (UNSC) Resolution 1540 and the currently developing Arms Trade Treaty, as they provide the background for state capacity building to strengthen export control laws. Utilizing the history and perceived effectiveness of these regimes and efforts, he then explores six factors for regime effectiveness. These factors are derived from existing literature of security and arms control regimes.

- The dual-use relationship of the technology
- Transparency within the process of regime management
- The threat of the technology
- Mobility of technology production

[8] John Forge, "A Note on the Definition of 'Dual-Use'," *Science, Engineering and Ethics* 16, no. 1 (2012): 111.

- State interest in the regime, relative to their other interests
- Capability for capacity-building

The hypothesis is that these six variables directly affect the feasibility of a global IED regime in an equal manner. A few of the factors include coordination and cooperation among states, while also encouraging enhancement of domestic export control laws. The global nature of the IED threat may create incentive to control these items, especially to protect against domestic terrorism. Each of these variables is not individually limiting factors, but in combination, can provide evidence for the feasibility of a new IED regime.

D. LITERATURE REVIEW

Although no existing unclassified literature refers to a global export control regime for IED making materials, many scholars have analyzed the existing export control and nonproliferation regimes. Drawing from this literature, the author has identified the most important factors or variables to determine regime effectiveness that can be applied to a new IED regime. First, by defining what a regime is, it helps to describe the importance of international cooperation concerning the feasibility of a new regime. Next, an examination of the current IED literature defines the boundaries on which an IED control regime would focus, due to the vast nature of technology that could be used. Further, he identifies the gap between the manufactured material and how it is put to use in an IED. Finally, he examines the literature about the global effort to combat the use of IEDs both in Iraq and Afghanistan and also for world wide domestic terrorism. By surveying regime theory, the technology in question, the current global counter IED effort and the existing literature on regimes to curtail WMDs, he can then identify the gaps in the current information, and determine where to apply the variables to survey the feasibility of an export control regime for IED making materials.

1. Regimes: What Are They?

Regimes consist of several actors converging on specific issue areas, in which interaction facilitates decision making on a collective level.[9] These regimes go beyond simple temporary arrangements; instead, they provide long-term arenas for collective interests. Both Robert Keohane and Stephen Krasner view regimes as being a set of norms and expectations that facilitate cooperation, more so than the following of the states' own self-interests.[10]

International regimes are developed in a variety of contexts, to include security and economic arrangements. Liberal institutional theory provides a stronger understanding of why regime cooperation works, and how it can be applied to this thesis question. This literature helps show why regimes function, and assists in determining the feasibility of a new regime based on the interest of combating the supply of IED-making material.

2. The IED Technology in Question

Part of the difficulty in establishing such an export control regime remains in identifying IED material, due to the improvised nature of the weapon. Limiting the technology to three specific items provides a framework for which to determine regime effectiveness. Although no consensus exists on the particular technologies responsible for the majority of IEDs, this thesis reviews three well-known IED precursor materials items used by criminals, insurgents, and terrorists throughout the world.[11]

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[9] Stephen D. Krasner, "Overview," in *International Regimes*, ed. Stephen D. Krasner (Ithaca, NY: Cornell University Press, 1983), 1–22.

[10] Robert O. Keohane, "Cooperation and International Regimes," in *After Hegemony* (Princeton, NJ: Princeton University Press, 1984), 49–64.; Krasner, "Overview," 2.

[11] Subcommittee on Near Eastern and South and Central Asian Affairs, *Jamming the IED Assembly Line: Impeding the Flow of Ammonium Nitrate into South and Central Asia*, 111th Congress, 2nd sess., 2010.

The first item is ammonium nitrate (AN), which is a nitrogen rich fertilizer that is easily fashioned into a high explosive now taking the place of the main charge in an IED. When mixed with an oxidizing agent such as fuel oil, Ammonium Nitrate (AN) can be just as deadly as any conventional weapon.[12]

The second item is the Dual-Tone Multi-Frequency (DTMF) Board. This technology was originally designed as circuitry for automated telephone systems, using touch-tone dialing to navigate the system.[13] However, as a field expedient circuit board, it is the triggering mechanism for Radio Controlled IEDs.[14]

Figure 3. An EOD Technician Holds Up a DTMF IED Triggering Device Found in Iraq.[15]

This item can be produced in mass quantity in a package with the circuitry soldered on and ready for use, which makes it quite easy for the maker of the device to employ it.

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[12] Subcommittee on Near Eastern and South and Central Asian Affairs, *Jamming the IED Assembly Line: Impeding the Flow of Ammonium Nitrate into South and Central Asia*.

[13] Stanley T. Naudus, *System and Method for Efficiently Transporting Dual-Tone Multi-Frequency/Multiple Frequency (DTMF/MF) Tones in a Telephone Connection on a Network-Based Telephone System*, ed. 3, Com Corporation, vol. US 6,259,691 B1, 2001; International Telecommunications Union, *ITU-T Recommendation F.902: Operations and Quality of Service Human Factors* (Helsinki: International Telecommunications Union, 1995); J. C. Foster et al., "An Experimental Evaluation of Preferences for Data Entry Method in Automated Telephone Services," *Behaviour & Information Technology* 17, no. 2 (March 1998): 82–92.

[14] U.S. Department of Defense, *JTF-GTMO Information of Detainees: Information on Guantanamo Detainees*, March 4, 2005, http://www.defense.gov/news/mar2005/d20050304info.pdf.

[15] House Armed Services Committee: Subcommittee on Oversight and Investigations, *The Joint Improvised Explosive Device Defeat Organization: DoD's Fight Against IEDs Today and Tomorrow* (Washington, DC: HASC, 2008).

The third item is the Passive Infrared (PIR) sensor, which was predominantly used in Iraq after Coalition Forces began jamming the DTMF signals to the devices. A PIR sensor utilizes heat or microwave technology in intrusion detection systems.[16] In the field, they are used much the same, and when timed just right, can cause significant damage to passing vehicles and personnel.[17]

Further literature, including DOD reports and non-scholarly articles, discuss the use of IEDs on the battlefield. A 2005 unclassified report on interrogations conducted by Joint Task Force (JTF), Guantanamo Bay, Cuba, provides insight into not just terrorist activity, but also the capacity for bomb making. According to this report, one captured bomb maker described his ability to construct a "complex detonation system – a Dual-Tone Multi-Frequency encode/decode system…now being used in Iraq."[18] Little has been written about PIR systems, as there have only been reports submitted after U.S. troops prosecuted several caches in both Iraq and Afghanistan, finding several of these items, as well as other bomb making material. One magazine article describes the PIR as a triggering and firing mechanism for explosively formed penetrators, a device that caused many more casualties per device than any other firing mechanism/device combination. According to Glenn Zorpette, this firing mechanism came in response to the Coalition efforts to jam their DTMF radio firing device signals. Because of this effort, the insurgents moved to a victim-operated firing device, utilizing the PIR sensor as a trigger.[19]

What the literature does not show is the link between the manufacturer of the technology and the specific devices found on the battlefield. In this respect, there is both a gap in the global effort, as well as the gap in the literature that describes this link. There

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[16] Global Sources, "Passive Infrared Detector Manufacturers & Suppliers," (n.d.), http://www.globalsources.com/manufacturers/Passive-Infrared-Detector.html; Pinhas Shpater, *Passive Infrared Motion Detection Circuit having Four Comparators*, vol. 5,886,632, 1999; James Martin, "Dragon's Claws: The Improvised Explosive Device (IED) as a Weapon of Strategic Influence" (master's thesis, Naval Postgraduate School, 2009), 1–111.

[17] Glenn Zorpette, "Countering IEDs," *IEEE Spectrum*, September 2008, 26.

[18] U.S. Department of Defense, *JTF-GTMO Information of Detainees: Information on Guantanamo Detainees*, 1.

[19] Zorpette, "Countering IEDs," 26–35.

are listings for manufacturing companies for both PIR and DTMF technology that can be ordered directly from the Internet.[20] This provides the target for where this proposed export control regime will focus to control the flow of material.

3. IEDs: Current Global Efforts

Currently, the U.S. military along with various government agencies are leading the global effort to counter IEDs. The literature that comes closest to examining the efforts of controlling the flow of IED making material is outlined by reports from the Department of Homeland Security (DHS) as well as the US House Armed Services Committee. These reports explain that what initially started as an effort to control the worlds supply chain and secure borders ultimately spawned Project GLOBAL SHIELD in 2010. Project Global Shield is a DHS effort, working with the World Customs Organization, as well as the United Nations Office on Drugs and Crime, Interpol and 60 countries that share information on the transfer of chemicals across borders throughout the world.[21] This congressional hearing also points to the efforts that the governments of Afghanistan and Pakistan need to take on in order to help with this charge. The hearing emphasizes the need to enact law that bans the production of AN to map out the supply chain for the items in question.[22] This global interagency effort is continuing to grow, with major input from the United States while also creating training opportunities for partner nations to learn how to control these items at their own border.

A gap in the literature that describes the counter-IED efforts of other countries, and not just U.S. efforts, remains. Two key themes to the literature concern IEDs and countries other than the United States. The first theme reflects countries affected by IED

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[20] Aleph America, "Aleph Passive Infrared Detectors," (n.d.), http://www.aleph-usa.com/Aleph-Products/Passive-Infrared-Detectors; Alibaba, "China DTMF Manufactures, Suppliers and Companies," (n.d.), http://www.alibaba.com/countrysearch/CN/dtmf.html; The Find, "Dtmf Board | Shop Dtmf Board Sales & Prices at The Find," (n.d.), http://www.thefind.com/electronics/info-dtmf-board; Global Sources, "Passive Infrared Detector Manufacturers & Suppliers."

[21] Subcommittee on Near Eastern and South and Central Asian Affairs, *Jamming the IED Assembly Line: Impeding the Flow of Ammonium Nitrate into South and Central Asia*; "Closing Remarks to Global Shield Seminar," *Federal Information & News Dispatch, Inc.*, October 13, 2010.

[22] Subcommittee on Near Eastern and South and Central Asian Affairs, *Jamming the IED Assembly Line: Impeding the Flow of Ammonium Nitrate into South and Central Asia*.

detonations while supporting coalition efforts in either Iraq or Afghanistan. Currently, U.S. and UK defense forces are the two advocates for enhancing training and technology prior to entering theater to combat the effects of IEDs. This effort focuses on training supporting countries, such as the Georgia, The Netherlands and Australia in the counter-IED fight. The United States also conducts training through the Joint Multinational Training Command (JMTC) to forces supporting the International Security Assistance Force (ISAF) in Afghanistan prior to deploying into theater.[23]

The second part involves domestic terrorism in countries throughout the world. Several reports show that India, Pakistan, Colombia, the Philippines, and Thailand, as well as a number of smaller countries, have been the center of bombing attacks that account for the nearly 250 IED incidents throughout the world every month.[24] Each of these countries deals with IEDs by ensuring the readiness of the local police bomb squads. The consensus in the literature shows that countries other than the United States are affected by IEDs and they are making limited efforts to combat the end use of the devices. It appears however, that these countries are relying on the United States to enhance their counter-IED efforts. For example, JIEDDO has taken the lead on a global effort by ensuring training and technology is used to defeat the devices found. Project Global Shield is another example, as it shows how the United States is taking the lead role to stop the flow of AN while also working with global policing agencies to enhance the strength of the global effort. This gap in effort outlined by the literature remains the focal point of the possibility of a global regime to slow the material used to make the devices.

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[23] Denver Makle, "Joint Multinational Training Command," *Army* 61, no. 3 (March 2011): 72–80, http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=Joint+Multinational+Training+Command&title=Army&issn=0004-2455&date=2011-03-01&volume=61&issue=3&spage=72&au=Makle%252C+Denver.

[24] Joint IED Defeat Organization, *2012–2016 JIEDDO Counter-IED Strategic Plan Released*.

4. Existing Regimes: The Framework for Future Regimes

The consensus among the global export control literature identifies four main efforts to restrict technology flows.[25] The first is the NSG, which was created to strengthen the Nuclear Nonproliferation Treaty by controlling technology, materials and supplies since the mid 1970s. Second is the AG, which does the same for both the Chemical and Biological Weapons Conventions. The third regime, the MTCR, was created to control the flow of missile technology as a delivery method for possible nuclear weapons. The fourth and final regime is the WA, which helps control both restricted dual-use items, as well as controlled conventional munitions.

The gap specifically addressed by an IED regime is the lack of control for these items in the current export control regimes. These regimes are all voluntary entities, in which states gather to strengthen their own domestic export control efforts and provide a transparent look into global trade concerning these technologies.[26] These regimes do not exist to stop the flow items completely; instead, they provide the framework to monitor end user arrangements while also providing an international forum in which states can interact. Each of these regimes consists of a lengthy control list that includes technology decided on by consensus. Although the control lists consist of precursors for a number of technology items, including frequency oscillators (found in the Wassenaar Control List Category 3), none specifically mention IED materials, nor are countries considering this technology as being in the realm of possibilities for being used as IEDs.

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[25] Michael Beck and Seema Gahlaut, "Creating a New Multilateral Export Control Regime," *Arms Control Today* 33, no. 3 (April 2003): 12–18. http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=Creating+a+new+multilateral+export+control+regime&title=Arms+Control+Today&issn=0196-125X&date=2003-04-01&volume=33&issue=3&spage=12&au=Beck%252C+Michael%253BGahlaut%252C+Seema; Michael Beck, "Reforming the Multilateral Export Control Regimes," *Nonproliferation Review* 7, no. 2 (2000): 91–103; Scott Jones, "Resolution 1540: Universalizing Export Control Standards?" *Arms Control Today* 36, no. 4 (May 2006): 18–22, http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=Resolution+1540%253A+Universalizing+Export+Control+Standards%253F&title=Arms+Control+Today&issn=0196-125X&date=2006-05-01&volume=36&issue=4&spage=18&au=Jones%252C+Scott; Andrew Latham and Brian Bow, "Multilateral Export Control Regimes: Bridging the North-South Divide [MERCs]," *International Journal* 53, no. 3 (Summer 1998): 465–486.

[26] Beck and Gahlaut, *Creating a New Multilateral Export Control Regime*, 12–18; Latham and Bow, *Multilateral Export Control Regimes: Bridging the North-South Divide [MERCs]*, 465–486.

The four principal export control regimes provide a framework for a regime that utilizes control lists to focus on the technology in question. Another important factor in export control is the ability to boost the capacity of member states, and those states that wish to become members. Literature on conventional arms trade provides the ability to establish the variable of capacity building through a more normative lens. Currently, the Arms Trade Treaty, a proposed effort put forth by the United Nations Security Council (UNSC), provides institution and capacity building in nations that do not have the ability to control arms trade due to the weak infrastructure of the government.[27] This effort also provides the ability for all nations willing to abide by international arms trade to establish standards on par with the international efforts.

Further literature on this subject revolves around the UNSC Resolution 1540 established in 2004, which calls on nations to strengthen domestic laws to control the flow of WMD material.[28] Although this resolution calls on countries to enhance their own export control efforts, it does not provide the capacity for strengthening the infrastructure. The Center for International Trade and Security (CITS) is currently leading this effort in both strengthening current export control regimes while also providing capacity building for those nations that lack the ability. Established by the University of Georgia's School of Public and International Affairs, CITS has conducted legislative outreach in China, India and the Caribbean, and provides training for these states to comply with UNSC Resolution 1540.[29] By drawing on the literature of capacity building efforts in the export control arena, the author is able to provide an example of the enforcement of regime efforts.

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[27] Arms Trade Treaty, "Preparatory Committee," (n.d.), http://www.un.org/disarmament/convarms/ATTPrepCom/; Oxfam, *National Implementation of the Proposed Arms Trade Treaty: A Practical Guide* (CITS/Oxfam, 2010).

[28] Andrew Semmel, "UN Security Council Resolution 1540: The U.S. Perspective," *Hampton Roads International Security Quarterly*, no. 15369609 (October 15, 2004): 29–32, http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=UN+Security+Council+Resolution+1540%253A+The+U.S.+Perspective&title=Hampton+Roads+International+Security+Quarterly&issn=1536-9609&date=2004-10-15&volume=1&issue=&spage=29.32&au=Semmel%252C+Andrew; Jones, "Resolution 1540: Universalizing Export Control Standards?" 18–22.

[29] Center for International Trade and Security, "Strategic Trade Control," (n.d.), http://cits.uga.edu/programs/STC.html.

Although the literature does not address the feasibility of a new regime, one piece particularly focuses on regime effectiveness based on factors of success. In her doctoral dissertation, Nicole Burtchett addressed how security regimes could succeed under limiting conditions. She identifies the three regimes as being the nuclear, biological and chemical regimes, as well as the ancillary organizations that aid in the nonproliferation efforts.[30] This dissertation examines the three regimes and evaluates them through seven hypotheses that link transparency, cooperation, confidence, verification, leadership and coverage while also linking to the consensus of variables in the literature.[31] The author intends to draw on this literature to define the variables that form the basis for evaluation of the current export control regimes, as well as the possibility of a new IED export control regime.

Examining the feasibility of a new export control regime exposes the issues that currently trouble the existing regimes. Both Michael Beck and Andrew Latham are critical of the current MERCs. First, Beck identifies the grander issues that plague multilateral arms control, in which governments struggle to coordinate efforts to control listed items. He claims the main weaknesses are the informal nature of the regimes, while also being contested with global pressures of international trade.[32] Due to the informal nature, Latham also highlights the divide between what he calls the "North" and "South," or the haves and have-nots. This division creates legitimacy issues, in which one set of countries is forming a cartel against those that do not have the technology.[33] Burchett emphasizes these very issues and explains in her findings that transparency and confidence are the two main variables in enhancing the current regimes effectiveness.[34] Each author stresses ways to strengthen the existing regimes by making the effort more

[30] Nicole K. Burtchett, "Nuclear, Biological, and Chemical Weapons Regimes: Finding Success Under Limits" (PhD diss., Washington State University, 2009).

[31] Ibid.

[32] Beck and Gahlaut, *Creating a New Multilateral Export Control Regime*, 12–18.

[33] Latham and Bow, *Multilateral Export Control Regimes: Bridging the North-South Divide [MERCs]*, 465–486.

[34] Burtchett, "Nuclear, Biological, and Chemical Weapons Regimes: Finding Success Under Limits."

transparent. Again, these control regimes focus more on larger, more dangerous weapons and technologies, but are still important to draw on to determine the feasibility of a new regime.

For the purposes of an IED control regime, the WA comes the closest to filling the need, as it is a dual-use and conventional weapons control effort. However, it still does not limit the technology relevant for IEDs. The WA, like the other regimes, provides an international forum to strengthen existing domestic export control laws for those who are signatories. They have classified the current technologies, and published a control list for states by which to abide.[35] This regime also has its own issues with the ability to affect export control. In a Government Accountability Office report that examined the ability for China to acquire and advance its semiconductor industry, it specifically lists the WA as lacking the ability to prevent the acquirement of dual-use technologies.[36]

5. Literature Review Conclusion

The literature highlights that other countries are affected by IEDs, and the United States seems to be leading the global effort in attempting to counter the devices and training those who will come in contact with them. Nothing is written about a new regime to control the materials used to make IEDs; however, a global effort exists to stop the flow of chemical precursors used in IEDs. In the same respect, global efforts have been used to control the flow of nuclear, biological, chemical, missile and dual-use technologies through regimes. Using the same control frameworks for the existing technologies and applying them to control IED making materials would require some of the same efforts in creating both transparency and confidence would be needed to make a regime such as this effective.

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[35] Jaime A. Joiner, "Dual-use Export Control Laws on Nanotechnologies," *Nanotechnology Law and Business* (Spring 2008): 53–64; Wassenaar Arrangement, "The Wassenaar Arrangement | Homepage," (n.d.), http://www.wassenaar.org/.

[36] U.S. Government Accountability Office, *Export Controls: Rapid Advances in China's Semiconductor Industry Underscore Need for Fundamental U.S. Policy Review* by Joseph A. Christoff, (GAO-02-620), Washington, DC: GPO, 2002.

E. METHODS AND SOURCES

This thesis attempts to answer the main research question by using a comparative approach that draws on the existing literature of the current export control regimes. A historical analysis identifies the six variables that some scholars suggest promote regime effectiveness and provide the framework for an IED regime. In an attempt to answer the main research question as to the feasibility of an export control regime to control IED making material, an understanding of international relations theory is used to examine the collective security efforts of the existing regimes by drawing on the neoliberal institutional framework for cooperation among these regimes. Finally, a cursory review of the capacity building efforts of the current export control regimes shows the importance of strengthening the enforcement capabilities by all current and future members of these regimes.

F. THESIS OVERVIEW

This thesis examines the feasibility of a global regime to control the movement of specific IED materials. To accomplish this goal, the thesis is divided into five chapters. Chapter I presents the main question, discusses its significance, and reviews the existing literature. Chapter II highlights the methods that have been undertaken to control the IED problems, both on the battlefield, as well as throughout the world and why they have not adequately countered the network of exported technologies used in these devices. This chapter also outlines the specific material included in the control lists of the regime. This thesis focuses on three items, ammonium nitrate as an explosive, DTMF boards and PIR sensors.

Chapter III examines the current arms and dual-use export control regimes, as well as what variables make them effective or ineffective.

Chapter IV applies the variables presented in the previous chapter to analyze whether a regime to counter the flow of materials used in IEDs is feasible or infeasible.

Chapter V restates the hypothesis, as well as presents the findings in the context of the greater significance of the issue by examining how it affects the use of IEDs. Further, it provides implications for further examination of new technologies that can be used in these devices.

G. FINDINGS

Based on assessment of the existing regimes concerning the variables presented, the author found that only three of the variables play a key role in the success of the four MERCs. Mobility of technology production, threat of the technology and state interest relative to their other interests were found to be the important variables, while the latter two were found to be the most important. Those successful regimes had easy to control technology because it was difficult to move the technology sources out of the supplier state without raising flags. These regimes also had technology universally considered quite dangerous when proliferated into the hands of an untrusted agent, which leads to states having a keen interest in the regime and its success.

These variables were further applied to a new regime for IED materials. The findings show that the technology that this regime would control was quite mobile, which would lead to difficulty in controlling its movement, and thus, undermine the regime's purpose. Furthermore, the findings present that the threat of this technology is localized and specific to a few countries, unlike the WMD regimes, which is more widespread. The lack of a grander threat reduces the interest that states would have in creating a new regime. Utilizing these three variables, the analysis shows that it would be difficult to implement a successful regime to control the flow of IED material.

II. IED MATERIAL AND THE CURRENT GLOBAL COUNTER-IED EFFORTS

A. INTRODUCTION

The previous chapter introduced the importance of the IED threat, especially as it has become a tool of the insurgency in the Global GWOT. The improvised nature of these devices implies that the material can be any ordinary civilian technology; however, some specific items used in modern IEDs can be traced back to the manufacturer. This chapter begins by expanding the history of IEDs, and then identifies major players and efforts in the current counter-IED battle. Finally, the chapter concludes by identifying the three technologies used in IEDs that are the focus of a new export control regime to control IED making materials.

B. HISTORY OF IED USE

An IED is defined as a "homemade" device used to cause death or injury, which can be employed against a specific target or the mass population.[37] By its very definition, the items are improvised, usually made from either military ordnance, or commercially available material that can be fashioned into a device. Many times, the main charge of the device includes some form of high explosive (HE), but can also include chemical, biological or even radiological material.[38]

The GWOT has brought the use of IEDs to the forefront, yet many examples of IED use in previous wars exist. Many of these uses are confined to the 20th century; however, the U.S.'s Joint Improvised Explosive Device Defeat Organization has listed its use as early as 1605. In this instance, radicals attempted to assassinate King James I by attempting to blow up the British Parliament.[39] Among the more recent examples of its use are guerilla forces employing these devices in both World War II and the Vietnam

[37] Global Security, "Improvised Explosive Devices (IEDs) / Booby Traps," (n.d.), http://www.globalsecurity.org/military/intro/ied.htm.

[38] Ibid.

[39] Joint IED Defeat Organization, *2012–2016 JIEDDO Counter-IED Strategic Plan Released*.

conflict. In Vietnam, IEDs in the form of mines were used against U.S. forces both in the water and on land.[40] The use of IEDs increased in sophistication during the Northern Ireland conflict. In this conflict, the Irish Republican Army (IRA) became well known for employing remote-controlled devices against the British Army starting in the 1970s.[41]

Although IEDs have been around for many years, the GWOT has defined the devices known today. Starting in October 2001, insurgents have employed IEDs through roadside emplaced bombs, personal-borne and vehicle-borne devices, which account for up to 70 percent of coalition combat casualties.[42] In the early part of the wars, IED main charges were mainly constructed of un-exploded ordnance items left over from previous conflicts, with rudimentary triggering devices. As the war continued, the level of conventional munitions was depleted, while the sophistication of the devices rose as bomb makers began to experiment with new techniques using commercial technologies. In 2007, a shift occurred in IED events that moved from Iraq to Afghanistan. Clay Wilson, a specialist in technology and national security, credits this swing to effective countermeasures in Iraq, and a lack of focus, as well as increased fighting postures in Afghanistan.[43] These two battlefields have shown the growth in sophistication of the devices, and provide examples of employment for the technology that would be controlled in an IED export control regime.

C. CURRENT EFFORTS IN COUNTERING IEDS

The previous chapter highlighted some off the global efforts to counter IEDs, with the United States leading the charge by creating JIEDDO in 2006 out of its predecessor, the Army IED Task force.[44] It also showed that other countries were becoming involved in the counter-IED effort; however, it appears that this effort is restricted to the battlefields of Iraq and Afghanistan. British and Australian forces have also become an

[40] Joint IED Defeat Organization, *2012–2016 JIEDDO Counter-IED Strategic Plan Released*.

[41] Ibid.

[42] U.S. Library of Congress, Congressional Research Service, *Improvised Explosive Devices (IEDs) in Iraq and Afghanistan: Effects and Countermeasures*.

[43] Ibid.

[44] Joint IED Defeat Organization, "Defeat the Device," (n.d.), https://www.jieddo.dod.mil/defeat.aspx.

integral part of the JIEDDO effort by attending training sessions with JIEDDO counterparts to gain more knowledge, as well as prepare their own forces to face the threat of IEDs in both theaters. These three appear to be major players in the counter-IED fight, but U.S. involvement seems to dominate this effort.

Although the focus of JIEDDO is to defeat the device, attack the bomb-building network, and train the force to seek out and destroy the devices, much can be said about the efforts to control the supply line. As mentioned in the previous chapter, attacking the network does not consist of the "up stream" effort in stopping the flow of material. Instead, the House Armed Services Committee (HASC) set out to do something about the transfer of this material into the theaters of war. Known as Project/Operation Global Shield, this multi-agency task force has set out to stop the flow of Ammonium Nitrate across borders throughout the world, especially Afghanistan.[45]

The project originally started as an effort to stop the flow of narcotics and criminal activity that threatened the national security of the United States, but now focuses on stopping the flow of chemical precursors used to produce explosive threats. The main agencies involved include the Department of Homeland Security (DHS), the World Customs Organization (WCO), the International Criminal Police Organization (INTERPOL), and the UN Office on Drugs and Crime (UNODC), while also augmented by 60 additional countries.[46] This effort was spawned by the increasing use of the fertilizer throughout the South Asia region, particularly Afghanistan and Pakistan, but is also a response to the use throughout the world.

Currently, DHS has created an AN security program throughout the United States to ensure the material is not being used for nefarious or terrorist activities by creating a registration program for purchasers and sellers of the AN that utilizes U.S. law to enforce

[45] Subcommittee on Near Eastern and South and Central Asian Affairs, *Jamming the IED Assembly Line: Impeding the Flow of Ammonium Nitrate into South and Central Asia*.

[46] "Closing Remarks to Global Shield Seminar."

the program.[47] This enforcement technique has been the basis for the international effort that has netted 35 seizures of chemical precursors in 2011, from Afghanistan to central Africa.[48]

Although current efforts do exist to counter the IED threat, much remains reactionary to the building and placement of the devices, instead of stopping the flow of materials. JIEDDO continues to spend billions of dollars to defeat the devices, much of it through technology, but shows little effort in attempting to break the technology supply chain from the start. Project Global Shield provides more of a supply defeating effort, but focuses solely on the chemical precursors, not the technologies in question. A more multilateral approach, including government actors, may help the supply chain effort, while also encouraging more interagency and international cooperation in this effort.

D. TECHNOLOGIES IN QUESTION

The technologies chosen to be the focus of this regime are examples of both the simplicity and sophistications of the IEDs found today. As history suggests, devices become evolutionary in war due to the employment-countermeasure game that seems to develop. Of the three items in question, AN has the longer history of being employed in explosive devices. The other two items have developed a reputation over the last 10 years as being tied to IED-making material, which makes them a dual-use item. Before this time, they were more commonly used in civilian technology. Yet, all three items have found themselves important devices in warfare.

1. Ammonium Nitrate

AN is a combination of ammonia salts and nitric acid, commonly used as a fertilizer.[49] However, dating back to the 1950s, AN has known to be used as the main charges of explosive devices, most famously the Oklahoma City Bombing in April

[47] Department of Homeland Security, "DHS | Ammonium Nitrate Security Program," (n.d.), http://www.dhs.gov/files/programs/ammonium-nitrate-security-program.shtm.

[48] Brian S. Davis, *Program Global Shield: Detection Technology in Support of Program Global Shield* (Brussels: U.S. Immigration and Customs Enforcement, 2012).

[49] Britannica Online Encyclopedia, "Ammonium Nitrate (Chemical Compound)," (n.d.), http://www.britannica.com/EBchecked/topic/21045/ammonium-nitrate.

1995.[50] Although it has explosive properties inherent in its chemical makeup, this dual-use product is made more lethal when mixed with fuel oil (known as ANFO), as was the case in the Oklahoma City incident. In this case, Timothy McVeigh packed several barrels of this mixture in a large rental truck and parked it in front of the Alfred P. Murrah federal building. Other instances of its use include bombings in London, South America, Pakistan and Indonesia.[51] The ease of obtaining and creating the mixture has been cited as the main reason why this chemical precursor has been used in large bombing events.

As AN was easy to obtain and mix with an oxidizer to create an explosive grade main charge, it was an obvious answer for insurgents running low on cache material to create new IEDs in both Iraq and Afghanistan. The depletion of material was due to the increased usage of conventional weapons fashioned into IEDs, as well as the coalition efforts to seek out and destroy those caches. The remote mountain locations of insurgent strong holds in Afghanistan, as well as its proximity to AN factories in Pakistan, has led to increased usage since 2007 that caused the Afghan government to ban production of AN in the country, which forced insurgents to acquire the material and cross it into Afghanistan.[52] The use of AN is not new to terrorists; however, new efforts to control its flow is now expanding throughout the world.

2. Dual-Tone Multi-Frequency

An IED consists of a main charge, a power source, initiator, and a trigger or a switch.[53] The trigger can become one of the more complex parts of the device itself, much like the items found by British forces in Northern Ireland. In Iraq and Afghanistan, many of the items found are either victim operated or command initiated, in which the person employing the device has control over the device and can set it off when desired,

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[50] James I. Rostberg, "Common Chemicals as Precursors of Improvised Explosive Devices: The Challenges of Defeating Domestic Terrorism" (master's thesis, Naval Postgraduate School, 2005).

[51] Ibid.

[52] Alan Cullison and Yaroslav Trofimov, "World News: Karzai Bans Ingredient of Taliban's Roadside Bombs," *Wall Street Journal*, January 23, 2010.

[53] Global Security, "Improvised Explosive Devices (IEDs) / Booby Traps."

which can be done either through remote control or radio control. DTMF is a type of Radio Controlled Improvised Explosive Device (RCIED) currently used on the battlefield, and is the focus of countermeasure devices used to jam those radio frequencies.

DTMF is a touch-tone technology created by AT&T to replace rotary dial telephone technology.[54] Embedded within the technology is the ability to send signals using the 12 numbers on the keypad, each of which represents a separate tone and frequency. This touchtone dialing system can be harnessed into sending and receiving coded information, and insurgents in Iraq and Afghanistan have taken advantage of this system. Although its use dates back to the Chechen conflict, the DTMF encode/decode system was being heavily used in both war fronts, as explained by detainees at the Guantanamo Bay detention facility.[55] One detainee even explained the complex firing system used to trigger IEDs on command, and offered critiques of some devices he had seen in the past.

The threat of this technology caused coalition forces, led by JIEDDO, to develop countermeasure systems to defeat the frequencies being used to trigger these devices, which was coupled with the effort to seek out and detain bomb makers. According to a International Security Assistance Force (ISAF) report on operations conducted throughout the country in 2009, both coalition and Afghan forces were adamant about finding the makers of these devises and detaining them to gather more information on bomb-making activities throughout the country.[56]

DTMF technology was an obvious target for coalition forces, and JIEDDO, due to its ability to be detected and defeated with a counter technology that would not be as simple for other victim-operated devices being employed to defeat the countermeasures put in place.

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[54] Annabel Z. Dodd, *The Essential Guide to Telecommunications* (Upper Saddle River: Prentice Hall PTR, 2002), 183.

[55] U.S. Department of Defense, *JTF-GTMO Information of Detainees: Information on Guantanamo Detainees*.

[56] "Suspected Insurgents Captured in Nangarhar," *Targeted News Service*, August 17, 2010.

3. Passive Infrared Detectors

Like DTMF technology, passive infrared detectors were originally used as a civilian technology prior to its employment in IEDs in the GWOT. Also like the DTMF, it is used as a triggering mechanism in IEDs, which creates a victim-operated situation. This initiation system was developed as a response to the Counter-RCIED Electronic Warfare (CREW) program set forth by JIEDDO, which made technology, such as DTMF, vulnerable to jamming techniques. Glenn Zorpette explains that this technology is usually used in conjunction with an explosively formed penetrator utilized to penetrate armored vehicles.[57] Using a PIR sensor as an initiation system would allow emplacers to arm the devices remotely before the jamming systems could render the radio signals useless. Then, the PIR system could use the heat signature of the vehicles to fire the devices.

The use of PIR technology is usually associated with intrusion detection systems, in which the detector uses either heat or microwave to detect movement that in turn creates an electrical signal, which when employed in an IED, triggers the device. The detector can be manipulated to create an area of sensitivity, which is used in the field to create a stand off distance between the detector and the target itself.

E. CONCLUSION

This chapter provided background and insight into the current IED problem by highlighting the history of the device, as well as how it has evolved into the current tool. Many of the techniques used by today's terrorists and criminals have ties to uses as early as World War II, with the IRA providing many of the specific techniques. The United States is not immune from being attacked on its own soil with these items either, as evidenced by the McVeigh Oklahoma City Bombing. The GWOT is a new campaign in unconventional warfare, with terrorists employing these techniques on a new front.

This chapter highlighted the technology in question, as well as the efforts used to defeat the three components: AN, the DTMF board and the PIR sensor. AN has been

[57] Zorpette, "Countering IEDs," 26.

employed as an explosive chemical for several years, with its use in high profile events. It is also the center of a worldwide police effort to stop its flow across borders. This effort comes after U.S. domestic controls placed on the manufacturing and distribution of the chemical. DTMF and PIR technologies have also been around for years, but as a more docile civilian technology. Terror suspects describe the use of DTMF technology as early as the Chechen conflict, while its employment in Iraq and Afghanistan has proven to be the center of the electronic counter-measure fight. PIR detectors are usually tied to explosively formed penetrators developed in Iran and smuggled in, while also having a close political tie with Sunni insurgents. Its employment comes only after the large effort to remove the frequency spectrums used to fire devices remotely.

Finally, the global effort revolves around two key aspects, JIEDDO's ground efforts, and Global Shield's interagency undertaking. The United States is a main player in both efforts, but remains engaged with other countries' forces and agencies to ensure all understand the importance of multi-party cooperation. JIEDDO continues to spend billions of dollars on countermeasure and training techniques, but eventually this will end. It is important to realize that these efforts lack the "up stream" efforts needed to stop a supply chain, which is what a global export control regime would be able to accomplish.

III. MEASURING THE EXISTING EXPORT CONTROL REGIMES

A. INTRODUCTION

The previous chapter focused on the importance of the worldwide IED threat, while also examining the most threatening specific technology, which can be traced and controlled through a possible export control regime. Also examined were the global efforts to defeat the IED threat, which highlighted where a new regime could possibly aid in the counter-IED fight. This chapter uses the existing regimes as a framework for the feasibility of a new export control effort. By examining these regimes through the six variables presented in the first chapter, the author will determine a new regime's focus for a new regime to be feasible. This chapter provides a short history of the four principle export control regimes, with an evaluation from the existing literature as to its level of success in limiting the spread of the technology. Next examined is each of the regimes through the following six variables.

- Dual-use relationship of the technology:
- Transparency within the process of regime management
- Threat of the technology
- Mobility of the technology production
- State interest in the regime, relative to other interests
- Capability for capacity building

Finally, the author presents his findings in the conclusion, which is evaluative of both the variables presented, and how they correspond to the successes or lack of success presented in the literature.

1. Definition and Importance of Variables

Before applying these variables to the regimes in question, it is important to first define the use of the variables in the context of this thesis. The first variable measures the dual-use relationship of the technology. Although many have defined "dual-use" technology as those items used for both civilian and military purposes, this thesis more

clearly delineates between the intended civilian use, as well as how the technology has been adapted for dangerous purposes. In the case of many of these technologies, the items are used in the same general field (e.g., nuclear or missile technology), which would widen the dual-use relationship. However, those technologies that can hide under its civilian use, but are being used nefariously, have a close relationship. This factor helps determine the difficulty in classifying technologies under each regime to control their export better.

Transparency in the international system is a factor difficult to classify. Many believe it provides insight as to the intentions of states. In the case of MERCs, they remain voluntary regimes, and require a certain amount of transparency for member states to agree on the issue areas of focus. This factor reflects the concept that regime members will abide by agreed upon frameworks and implements those ideas into domestic laws if they believe that others within the organization are doing the same. For the purposes of this thesis, the study of transparency includes both the management of the regime by its leaders, as well as the abidance of its members to the agreed upon framework.

In a broad sense, WMD technology and materials are inherently dangerous, which is the reason many of these regimes were created. The third factor measures just how threatening the technology controlled by each of the existing export control regimes is. This measurement remains a significant factor because it may determine just how interested members states are in agreeing to and enforcing the agreed upon export controls in each of the regimes.

The purpose of export control is to stop or slow the proliferation of dangerous items. The fourth factor looks at how easily the production can move, even with the implementation of export control. This ease is a very significant factor, as the main measure of success for a new regime is based on the limitation of the spread of the technology.

The idea that states voluntarily join and participate in voluntary export control regimes shows that some interest exists in controlling the export of WMD materials and

technology. This factor examines more closely the member states' interest relative to their other interests by taking into account other factors in this chapter, such as the threat of the technology. This interest remains important because these regimes are built on member states participating, agreeing to, and abiding by the rules set forth by the consensus of the group.

The final factor in this chapter is the capability of each regime to enhance the capacity of member state in implementing and enforcing the agreed upon export control efforts. Although none of the four-principle export control regimes have this capability yet, this section explains future efforts in implementing these capabilities to both strengthen the capacity of current member states, as well as those who wish to join in the future. This factor is important because not only does it expand the ability to garner more membership among the regimes, but it also strengthens the capability to enforce the laws, which in turn, enhances the transparency of the regimes.

2. Where these Variables Come From

Most of these variables were derived from literature on existing regimes. One such writing by Nicole Burchette outlines the common factors previously used in measuring general regime effectiveness, including state transparency, coverage of the regime, and enforcement.[58] She continues to explain that although these are the most common variables used in determining regime effectiveness, she modifies the variables and expands them to review the impact on nuclear, chemical and biological (NBC) nonproliferation regimes.[59] Much like Burchett, the author's review of the existing regimes and the subsequent review of a new regime will require some modifications to these common factors on regimes. Keeping the goal of this thesis in mind, the regime that he has proposed is one of lower technology items. A few of these variables are tailored to focus on the technology itself, as no other literature exists on such a matter. These variables help link the regime to the technology that they control, instead of the more common organizational view of the regimes.

[58] Burtchett, "Nuclear, Biological, and Chemical Weapons Regimes: Finding Success Under Limits."

[59] Ibid.

The author has also presented two organizational level factors. One is the common factor of transparency at the regime management level, which Burchette does utilize as well. He has also presented the variable that focuses on state interest, which is more commonly referred to as "state cooperation and confidence in the instrument."[60]

Finally, the variable of capacity building is a hybrid of the efforts put forth by both WMD regimes, as well as conventional arms treaties. This variable was chosen because it is an emerging effort to enhance the effectiveness of export control, and may or may not play a large role in either the current regimes, or the new proposed regime.

Examining the current principle export control regimes against each of these variables helps show which variables are most important in determining success, and in the next chapter, feasibility of a new regime. These factors highlight the issues with the technologies themselves, as well as the function of the regimes. It is also important to review the success or difficulties of the existing regimes independent of the variables presented. Along with the history of each regime, the author shows how each regime has succeeded or faltered based on previous literature. He then presents the six variables as they are measured against the four regimes, and concludes with the synopsis of the findings, including the variables that appear to be most important, and the link between variables that can then be presented in the next chapter.

B. HISTORY OF THE EXISTING REGIME EFFECTIVENESS

Multilateral export control regimes are voluntary, nonbinding arrangements designed to prevent the spread of WMDs, missile technology and other dual-use items that can be used for other than peaceful purposes.[61] Although they each focus on their respective weapons and technology systems, they collectively attempt to bring like-minded supplier nations together to stop the proliferation of WMD material. They work by focusing on the supply side, establishing a consensus on control lists of these sensitive items that would be implemented domestically by member nations to stem the flow of

[60] Burtchett, "Nuclear, Biological, and Chemical Weapons Regimes: Finding Success Under Limits."

[61] U.S. Government Accountability Office, *Nonproliferation: Strategy Needed to Strengthen Multilateral Export Control Regimes* by Joseph A. Christoff, (GAO-03-43), Washington, DC: GPO, 2002.

specifically identified technologies. Also, each of these regimes shares overlapping memberships of some sort, which ensure that those supplier nations are tracking all the WMD technologies in question.[62] The success of the regimes is based on their technical ability to limit the spread of technology among supplier and non-supplier states, as well as member and non-member states. The following is a short history of each of the four regimes, their focus, and whether or not they have been successful.

1. Nuclear Suppliers Group

The NSG is an informal group of states that puts controls on the export of technologies used to develop a nuclear weapons capability. It was born out of the Nuclear Nonproliferation Treaty (NPT) Exporters Committee (Zangger Committee), which was developed in response to the 1974 India Nuclear explosion. In this incident, India exploited agreements with Canada and the United States and acquired materials used to test their first nuclear device.[63] What transpired was the establishment of a new set of guidelines that attempted to close the loopholes in the nonproliferation efforts.[64] The first NSG guidelines were established in 1978 as a part of the IAEA safeguards to ensure that transfers of nuclear technologies were used for only peaceful purposes and not for unsafeguarded nuclear energy or weapons development.[65] This preliminary effort of the NSG was somewhat effective in strengthening the NPT and curbing proliferation, but would require a much larger effort if it were to keep up with the changes in nuclear technology.

The early 1990s became a turning point for the NSG owing to the discovery of large amounts of materials and equipment for a nuclear program in Iraq. Following this find, the NSG went a step further and added dual-use technologies for the development of

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[62] U.S. Government Accountability Office, *Nonproliferation: Strategy Needed to Strengthen Multilateral Export Control Regimes.*

[63] Fred McGoldrick, "The Road Ahead for Export Controls: Challenges for the Nuclear Suppliers Group," *Arms Control Today* 41, no. 1 (January/February 2011): 30–36.

[64] Ibid.

[65] Nuclear Suppliers Group, "Home-Eng," (n.d.), http://www.nuclearsuppliersgroup.org/Leng/default.htm.

nuclear programs, while also requiring full-scope safeguards by member nations.[66] Since this incident, the NSG has continued to update and strengthen its export control rules, as well as its control lists to take on new technologies and challenges that have arisen. The NSG has also enhanced its membership by expanding and accepting new members beyond those nuclear supplier states. Currently, the list of member nations sits at 46, with more geographically and politically diverse members to be accepted in the future.[67]

The determination of success of the NSG can be broken down into two phases. The first is the period between the inception of the regime and the establishment of controls over dual-use materials in the wake of discoveries in Iraq in the early 1990s. This phase of the regime left many loopholes that provided states the ability to obtain dual-use material that could help them create new nuclear programs, as well as circumvent the not yet established comprehensive safeguards.[68] This phase saw the export of these items to places like Argentina, Brazil, and of course, Iraq.

The second phase would be from the period of adoption of new comprehensive safeguards and the focus on dual-use material. This phase has had its challenges as well, with both Russia and China attempting to cite their own "grandfather clauses" in an attempt to transfer technologies to India and Pakistan, respectively.[69]

These challenges listed are indeed a proliferation issue, with clandestine networks providing the ability for increasing nuclear capability among nations like Iran, Libya and North Korea. However, the NSG can claim success in limiting the spread of the technology. As Fred McGoldrick states, "No NSG members have transferred enrichment or technology to states that did not already possess such plants."[70] The management of

[66] McGoldrick, "The Road Ahead for Export Controls: Challenges for the Nuclear Suppliers Group," 30–36.

[67] Ibid.

[68] Ibid.

[69] Ibid.

[70] Ibid.

the regime presents difficulties, with the major powers seeking loopholes to better the position of partner nations; however, the regime itself has been successful in limiting the technology from spreading too far.

2. The Australia Group

The AG was first established in 1984, as a response to the use of chemical weapons in the Iran-Iraq War by Iraq, a violation of the 1925 Geneva Protocol.[71] The purpose of the arrangement was to establish an informal regime to standardize export controls of precursor chemical and biological materials collectively. Like the other export control regimes listed, it also utilized a control list of these precursor items. This effort is seen as being complimentary to the 1972 Chemical Weapons Convention and the 1975 Biological Weapons Convention, while focusing solely on export control of these items.[72] Currently, the Australia Group encompasses 40 nations, as well as the European Commission.

Although the AG was founded in the mid-1980s as an effort to control exports from states, it has evolved along with the type of warfare presented in the 21st century. In 2002, the AG expanded its scope of controls to include counterterrorism measures also by establishing "catch-all" rules to prevent the proliferation of items that "could" be used in WMD production.[73] Currently, the group also tracks items considered "dual-use" chemical and biological equipment used to produce this material.

The success of the AG is difficult to measure, since it reaches across three different technology spectrums. What does make the AG somewhat successful is the close ties to the Chemical and Biological Weapons Conventions, which are binding treaties that allow for those states that are signatories to have a more binding obligation to stop the proliferation of this material. Since the AG is a voluntary subsidiary to these conventions, it works to enhance the non-proliferation efforts. However, James

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[71] "Chemical Weapons," (n.d.), http://www.fas.org/nuke/control/ag/docs/aus496.htm; Australia Group, "The Australia Group," (n.d.), http://www.australiagroup.net/en/index.html.

[72] Ibid.

[73] U.S. Government Accountability Office, *Nonproliferation: Strategy Needed to Strengthen Multilateral Export Control Regimes.*

Seevaranam emphasizes that the commitments to the CWC may override the AG. For example, the CWC calls for increased trade in precursor materials to certain countries in the Middle East, which works against what the AG control lists and agreements stipulate.[74]

The AG can claim success in the ability to lessen the transfer of sophisticated equipment used for both chemical and biological material. Seevaratnam explains that although the regime does not eliminate the development of chemical or biological programs, it does limit the source of high technology and high-end products that creates a choke point in the development of large programs.

Success within the AG can be limited to the development of larger programs through the control of technologically advanced items. However, it is difficult to control indigenous materials used in the development of smaller chemical and biological programs. Naturally occurring organisms are impossible to control; therefore, this regime will always encounter challenges.

3. Missile Technology Control Regime

The increasing threat of WMD proliferation also brought about concern for the proliferation of delivery systems for these weapons. Although agreements between the U.S. and USSR throughout the Cold War would refrain either side from selling missile material, instances occurred in which the United States aided its NATO allies and the USSR aided its Chinese and its Warsaw Pact allies.[75] The threat of missile technology proliferation also increased throughout the 1980s, with incidents in Iraq, South Korea, India and Libya, which prompted the establishment of the MTCR in 1987.[76] Since then, the regime has grown from seven original members to 34, and is labeled as the first

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[74] James I. Seevaratnam, "The Australia Group: Origins, Accomplishments, and Challenges," *The Nonproliferation Review* 13, no. 2 (July 2006): 401–415, doi:10.1080/10736700601012227, http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=The+Australia+Group%253A+Origins%252C+Accomplishments%252C+and+Challenges&title=The+Nonproliferation+Review&issn=1073-6700&date=2006-07-01&volume=13&issue=2&spage=401&au=Seevaratnam%252C+James+I.

[75] Dinshaw Mistry and Mark Smith, "Negotiating Multilateral Instruments Against Missile Proliferation," *International Negotiation* 10, no. 3 (2005): 425–451.

[76] Ibid.

international effort to control missile-related exports. Like other export control regimes, the MTCR is an informal gathering of member nations that exchange information on control efforts. It also uses control lists to stem the flow of technologies associated with missile systems.[77]

Although export control regimes are not meant to stop the flow of technologies completely, it should slow the ability to develop programs in the areas of concern. The MTCR can claim some success in its ability to slow, and in some cases, even change the minds of some states from producing medium-range missiles. It was able to block hundreds of transfers of components and technologies, while also influencing six countries against pursuing missile-building programs. However, the MTCR was still not able to prevent Israel, India, Pakistan, and North Korea from testing medium-range missiles in the late 1990s and early 2000s.[78] This period shows the lack of ability to limit the spread of missile technology, but with the addition of the Hague Code of Conduct, some improvement has occurred in the regime's ability to increase state interest and enhance transparency within the regime.

4. The Wassenaar Arrangement

The fourth group of the principle export control regimes is the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-use Goods and Technologies. As the name suggests, it applies to those items deemed dual-use by utilizing control lists agreed upon by all members of the regime. The WA was established in 1996 as a successor to the Coordinating Committee for Multilateral Strategic Export Controls (COCOM), which was a Cold War era effort to control dual-use technologies.[79] With 33 founding members, the WA initiated a new set of control lists of dual-use items, as well as dangerous conventional arms. Although the more controversial of the regimes, the WA has attempted to adhere to a consensus based, control-list managed export

[77] Missile Technology Control Regime, "Missile Technology Control Regime," (n.d.), http://www.mtcr.info/english/index.html.

[78] Mistry and Smith, "Negotiating Multilateral Instruments Against Missile Proliferation," 425–451

[79] Wassenaar Arrangement, "The Wassenaar Arrangement | Homepage."

control effort to close the gap in technologies not listed in previously established regimes that control WMD and missile technology.

The success of this regime is mixed. Although it is the only regime that puts a timeline on export denials, it is laden with many other inefficiencies that call into question the transparency of the regime management, as well as the interest that a state might have in fully enforcing the agreed upon rules. One such example includes the fact that the WA gathers information from its members once every six months, and summarizes it to the point that much of the information cannot be used. It would be more effective if the reports gathered and shared included such things as undercuts of license denials, approved items for transfer, and who actually received these items.[80]

One of the major challenges to this regime remains in the interest of its members. This regime focuses on conventional and dual-use items; much of it is based on rapidly evolving technologies coming from civilian industries and companies. The challenge for the WA lies in the idea that an increasingly globalized society allows for more movement of these technologies without the state even realizing it. Heinz Gartner also stresses that many times distributors get involved, which clouds the relationship between manufacturer and customer, that in turn, violates the terms of the end-user agreements required for export.[81]

Although the management of the regime attempts to limit the spread of dual-use technologies and conventional weapons, the spectrum is simply too broad to be effective. Much of it concerns state interest in economic gain rather than restricting technologies. Many times, those who wish to purchase something on the WA control lists can simply shop around if one country refuses them. Another part is that the technologies are just so vast that it becomes an issue trying to keep up with new advances in these fields, as well as production moving from one country to another. These examples correlate with the idea that the WA is viewed as the weakest of the four regimes.

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[80] The information in this paragraph was summarized from the GAO report on the strategy to strengthen multilateral export control regimes. For more on this see: U.S. Government Accountability Office, *Nonproliferation: Strategy Needed to Strengthen Multilateral Export Control Regimes.*

[81] Heinz Gärtner, "The Wassenaar Arrangement (WA): How it is Broken and Needs to be Fixed," *Defense & Security Analysis* 24, no. 1 (March 2008): 53.

C. MEASURING REGIMES AGAINST VARIABLES

1. Dual-Use Relationship

The term dual-use technology can be traced back to 1993, when the U.S. Office of Technology Assessment released a report on the technologies underlying the development of WMDs. It states that technology is considered dual-use when it is initially intended for civilian use, but has a much more nefarious military use as well.[82] Controlling dual-use technology has become a complex issue, mainly because restricting trade in certain technology sectors due to its possible hazardous use becomes an economic burden, especially to the exporting country. Among the four regimes, the dual-use relationship spans both dangerous military technology, as well as civilian industrial use. However, a close dual-use relationship occurs when the technology can hide under the civilian use but still be used for dangerous weapons. Analyzing the dual-use relationship among the four existing regimes will show how difficult it is for each of these regimes to first place these items on control lists, and then enforce the export of these items.

The NSG deals with the export of nuclear material, as well as the technology used to produce it. As stated in the previous section, the NSG shifted gears in 1992 and began focusing on the dual-use technology, which is the equipment used to produce nuclear material. First, the nuclear material itself can be deemed dual-use, as it can be used for power production, as well as weaponry. However, nuclear material can be delineated between the two based on its purity and amount, and therefore, can be removed from consideration in the context of this thesis. Therefore, a focus on the technology and equipment to produce nuclear material will show the dual-use relationship. In 1992, the NSG released an annex that included industrial equipment (spin and form flowing machines, high-temperature furnaces), materials (centrifuges, zirconium, lithium-6), enrichment production equipment (electromagnetic equipment), implosion development systems, and explosives (HMX and ultra-fast detonators).[83] Although termed dual-use, it

[82] Forge, "A Note on the Definition of 'Dual-Use'," 111.

[83] Jon B. Wolfsthal, "Nuclear Suppliers Group Agrees on 'Dual-use' Export Controls," *Arms Control Today* 22, no. 3 (April 1992): 19.

appears that the other use for many of the items on the initial control list are deemed for civilian nuclear power production, and therefore, still remain under the umbrella of nuclear material, either used for nuclear weapons or power. In other words, the dual-use relationship is not close because the relationship remains with nuclear technologies, and cannot hide under its civilian uses.

The AG deals with chemical and biological weapons. As with the NSG, the AG deals with both the material, as well as the technology used to produce it. To analyze the AG, it is necessary to examine both technologies separately. The chemicals named in the control list are precursor chemicals, that is, no need exists to list nerve, blister or blood agents, as they are obviously illegal to transfer under the CWC. However, these precursor chemicals can also be used in industry as well. The civilian uses of these chemicals make them vulnerable for use in weapons as well, and create a very close dual-use relationship.

Biological material does have a productive value in the civilian medical world that would increase the relationship between civilian and military use. Ronald Atlas and Malcolm Dando bring light to the situation in which biological material is required in life sciences, both for research and for healing, but also has a unique use in that it can produce biological weapons as well.[84] The potential for further research in this area can also be used to hurt and heal, as bioterrorism can expand beyond those known biological pathogens into an arena of new bio-hazards not known to those in the life sciences. Therefore, the dual-use relationship on the biological material side of the AG is quite close.

The last part of the AG's control list items are the dual-use technologies listed used to produce both chemical and biological material. The AG lists common chemical production items, such as storage tanks and reaction vessels, and biological fermenters, as well as centrifuges and filtration equipment.[85] Due to the specific nature of the items listed, it shows that the aim of export control within these technologies is to restrict the

[84] Ronald M. Atlas and Malcom Dando, "The Dual-Use Dilemma for the Life Sciences: Perspectives, Conundrums and Global Solutions," *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science* 4, no. 3 (2006): 276.

[85] Australia Group, "The Australia Group."

ability to make these items in large quantities, and to the purity specifications required for weaponization. These dual-use items are not necessarily common instruments.

The final two regimes examine only the technology in question, not the WMD precursor material that the NSG and AG also control. The MTCR was created to control the flow of missile technology used to possibly enhance the WMD delivery capability. However, the dual-use relationship is the WMD delivery system versus the space delivery vehicle system. Therefore, the relationship is open because they are the same systems, and this regime essentially restricts missile technology to those countries in the "north" in the north-south debate.[86]

Finally, the WA controls both dual-use items, as well as dangerous conventional weapons. The dual-use relationship is quite close in this regime, due to its conventional and dual-use control lists. The criterion for being on the control list is that the technology in question can be used to enhance military capability. Among the four regimes listed, this regime is the one with the closest relationship. Its control lists consists of various technological material quite often used in industry today, which makes its relationship, as well as its enforcement, quite difficult.

2. Transparency within Process of Regime Management

One reason export control regimes were developed was to bring transparency to the export control process. By allowing states to come to a consensus on an informal level, it would provide the ability for all to voice concerns over both the threat of the technology and the possible loss in comparative advantage concerning dual-use technologies. This method would both strengthen existing laws while also enhancing state cooperation within this area of concern. Transparency in this context refers to the management of the regime through decision-making processes, member admission, as well as implementation of the new rules. One key measure of success relates to the idea

[86] The north-south divide is a debate among those who believe that the "north" holds the technology, and therefore, becomes a cartel of sorts. The northerners in this case believe that export controls are legitimate and necessary to restrict dangerous technologies to those who can be trusted. For more on this subject see: Andrew and Bow, "Multilateral Export Control Regimes: Bridging the North-South Divide [MERCs]," 465–486.

that each member of the regimes in question implement and enforce the agreed upon export control laws in a way that all regime members see as fair and consistent.[87] The informal nature of the regimes allows for some transparency, but this section analyzes this factor based on the evolution of the regime process.

The NSG is a consensus-based organization like the other export control regimes; however, the threat of the technology also plays a large role in the decision making of the organization. Fred McGoldrick explains that the organization has expanded from only Western industrialized nations in to a much more diverse group that brings different, sometimes diverging interests to the decision-making table.[88] Transparency in this manner makes it difficult because nuclear powers tend to dominate the decisions within the organization because differing agendas exist within the organization that lead to decisions being made without the consensus. One example includes the United States pushing to change the current language of the NSG moratorium on the transfer of enrichment and reprocessing equipment. Some NSG members see this as threatening to their economic options, while others saw this as an attempt to widen the divide between nuclear weapon states and non-nuclear weapons states.[89] The NSG will continue to become less transparent as it increases in size as well. The more diverging interests between states, as well as more non-supplier states that wish to become part of this informal agreement, will cause those nuclear powerhouses to become the center of the decision-making body of this regime. Therefore, transparency within regime management is lacking for the NSG.

James Seevaratnam describes the AG as an organization that makes all decisions (policy, technical, membership oriented or any nonproliferation decisions) by consensus, which makes it more authoritative.[90] Being consensus based, the AG also uses three

[87] Cassady B. Craft and Suzette R. Grillot, "Transparency and the Effectiveness of Multilateral Nonproliferation Export Control Regimes: Can Wassenaar Work?" *Southeastern Political Review* 27, no. 2 (1999): 281.

[88] McGoldrick, "The Road Ahead for Export Controls: Challenges for the Nuclear Suppliers Group," 30–36.

[89] Ibid.

[90] Seevaratnam, "The Australia Group: Origins, Accomplishments, and Challenges," 401–415.

expert groups: the Implementation Experts Group, the Enforcement Experts Group, and the Information Exchange. Each of these groups is represented by all 39-member states, which helps streamline the decision-making process, all the while, attempting to enhance transparency within this organization. Seevaratnam also describes the AG as one that recognizes the sovereignty of its members while also maintaining open communications. He describes the "no undercut" policy of the regime, which all members of the regime become aware of one country that has denied an export license, to limit the ability for buyers to "shop around" for another country that would be willing to sell the technology.[91] Thus, transparency appears to occur within the regime management.

The MTCR deals with many of the same issues that the NSG deals with, in that the threat of WMD delivery systems is as dangerous as the weapons themselves. The existence of the MTCR angers many non-member states, as they believe that this regime is also a cartel of sorts that restricts the technology to those deemed most responsible. The decision-making process within the regime is a little different from the other consensus-based organizations. Instead, the members meet to exchange information, and are encouraged to follow and observe the informal MTCR guidelines "on the basis of sovereign national discretion and in accordance with national legislation and practice."[92] While annual plenary meetings occur, the group focuses more on outreach programs to keep members and non-members informed about the group's activities. The informal nature of the regime creates the ability for a more open forum within the management of the regime. However, the Hague Code of Conduct (HCOC), which was developed in November of 2002, has attempted to close the remaining gap in transparency within the missile proliferation control efforts.[93] The HCOC is not meant to supplant the MTCR; instead, it enhances the overall transparency of missile technology transfers. Therefore, because of this secondary effort, the management within the MTCR remains transparent.

The Cold War era COCOM was an export control regime to reduce the flow of WMD materials, which ended with the collapse of the Soviet Empire. From this Cold

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[91] Seevaratnam, "The Australia Group: Origins, Accomplishments, and Challenges," 401–415.

[92] Australia Group, "The Australia Group."

[93] Mistry and Smith, "Negotiating Multilateral Instruments Against Missile Proliferation," 425–451.

War effort came a more inclusive MERC. The WA was established with the intent of maximizing transparency among the 33 members. The key term in the establishment of the WA was that enforced controls would be "fair and consistent."[94] Due to the nature of the items that Wassenaar has been charged to control, the implementation of transparency within the regime becomes quite difficult. Dual-use technology is an inherent issue, and although the regimes claim that their intention is not to reduce a state's comparative advantage, it remains difficult to control items if it becomes bad for business. At its inception, the WA would bring transparency to the dual-use transfer issue; however, since then, it has had its issues. One example comes from a Government Accountability Office (GAO) report on the advance of China's semiconductor industry, in which they label the WA as one of the primary reasons that China has still managed to close the gap in this technology.[95] This report continues to state that the United States is the only state concerned with this gain in technology, which is consistent with another GAO report on nonproliferation that explains the WA's lack of information sharing is leading to states "undercutting" each other.[96] With this information, it shows that a lack of transparency exists within the WA.

3. Threat of the Technology

Another important factor in determining the measure of regime success remains in the threat of the specific technologies on which the regimes focus. While many of the technologies listed by the regimes may be dual-use, the dangerous military application of the technology worries member states. The danger of proliferation of these technologies is determinant of how interested a state is in enhancing not only its own export control laws, but also the laws of the other members of the regime. This section reviews both the materials and technologies controlled by each regime to determine how important the threat is to the outcome of export control consensus among the members of each regime.

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[94] Craft and Grillot, "Transparency and the Effectiveness of Multilateral Nonproliferation Export Control Regimes: Can Wassenaar Work?," 281.

[95] U.S. Government Accountability Office, *Export Controls: Rapid Advances in China's Semiconductor Industry Underscore Need for Fundamental U.S. Policy Review*.

[96] U.S. Government Accountability Office, *Nonproliferation: Strategy Needed to Strengthen Multilateral Export Control Regimes.*

The NSG is just one part of the overall nonproliferation effort to control material that can be used in nuclear weapons. This informal nature of the regime provides another layer of cooperation and participation to aid in stopping the flow of this material. The move by the NSG in 1992 to control dual-use equipment used to produce possible nuclear material enhanced the overall effort to control this material. All this being said, it is clear that the threat of this technology is high; not just the material itself, but even the slightest piece of equipment used in the generation of nuclear power or weaponry. Since this technology is quite threatening, the worldwide efforts among states to control the proliferation have remained contentious. For example, the United States looks at China as a possible aggressor because it intends on helping Pakistan by providing that country with a new nuclear reactor.[97] Other states can also see the United States in this manner, as it was attempting to exempt India from the comprehensive safeguard standards established by the regime in 1992. The threat of the technology that the NSG is charged with controlling remains high, as does the danger of proliferation.

Much like the technology in the NSG, chemical and biological material, when used as a weapon, can be extremely threatening. The AG was born out of the Iran-Iraq conflict, and to this day, the technology remains a threat. One example is the use of Sarin gas in the Tokyo subway system by the terrorist cult Aum Shinrikyo in 1995. According to Kyle Olson, this incident was not isolated, as the group attempted several times to utilize both a nerve agent, as well as other biological toxins throughout the early 1990s.[98] Another more famous use of this technology is the bioterrorism threat of anthrax that happened in the wake of the September 11, 2001 attacks. This attack targeted postal workers, politicians and media personnel through letters containing a white powder

[97] McGoldrick, “The Road Ahead for Export Controls: Challenges for the Nuclear Suppliers Group,” 30–36.

[98] Kyle Olson, “Aum Shinrikyo: Once and Future Threat?” *Emerging Infectious Diseases* 5, no. 4 (1999): 513.

substance. In all, 22 cases of anthrax were reported.[99] The threat of this technology is high, and it is continuous, as many of the other variables in this chapter enhance the threat of chemical and biological weapons.

The threat of missile technology proliferation is unique because the missiles themselves are not threatening, but the payloads they can carry are. As vehicles for WMDs, this technology remains a very threatening issue both worldwide, and regional. In 1999, members of the MTCR decided to focus on the issue of proliferation to regional powers because these states were looking and expanding their reach in the region using missiles.[100] Due to the potential of WMD delivery, this technology remains just as threatening as the technology covered in the NSG and AG.

While the WA is not an export control regime aimed specifically at WMD technology, it does have its place in controlling those dangerous conventional arms, as well as other technologies that have destabilizing effects.[101] Items, such as Small Arms and Light Weapons (SALW), as well as Man-Portable Air Defense Systems (MANPADS), are among some of the technologies that Wassenaar attempts to control. The threat is not necessarily about possessing these technologies, but rather the accumulation of these conventional weapons. The dual-use threat relates to items that can enhance conventional military capabilities and does not necessarily relate to any one specific type of technology.[102] Compared to the other regimes, the technology the WA attempts to control is not nearly as great. However, destabilizing weapons and technologies remain a threat to most regions throughout the world.

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[99] Shivang G. Joshi et al., "Anthrax in America 2001–2003," *Journal of the National Medical Association* 96, no. 3 (March 2004): 344–50.

[100] Mistry and Smith, "Negotiating Multilateral Instruments Against Missile Proliferation," 425-451.

[101] Gärtner, "The Wassenaar Arrangement (WA): How it is Broken and Needs to be Fixed," 53.

[102] Wassensaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, "Criteria_as_updated_at_the_December_2005_PLM.Pdf (Application/Pdf Object)," (n.d.), http://www.wassenaar.org/controllists/2005/Criteria_as_updated_at_the_December_2005_PLM.pdf.

4. Mobility of Technology Production

The mobility of certain WMD technologies depends on a few other factors listed in this section. The threat and dual-use relationship play a large role in how mobile the ability to reproduce WMD technologies is, as well as possibly move it to non-state actors. This section deals with how mobile a technology is, based on its ability to skirt the export control efforts.

The technology behind the NSG is quite important, and hardly goes unnoticed among supplier states and other members of the NSG. Since the dual-use relationship is not as close, the material and equipment that could produce nuclear power or a nuclear weapon is often traced back to the supplier. Also, the production of nuclear material requires natural resources only found in specific areas in the world. Therefore, nuclear material and technology is not very mobile.

Chemical and biological material is much more mobile than the technology listed by the NSG. Both the precursor chemical and biological material, as well as the dual-use equipment, can be transported and production begun elsewhere, away from the supplier state. Biological material is especially unique, in that a small strain of biological material can be "stepped up," or reproduced into large quantities from a smaller strain, which is especially threatening if the technology fell into the hands of non-state actors. However, the items listed by the AG are for much larger productions of this material. In all, the mobility of this technology remains high because of both the dual-use relationship, as well as the threat of the technology.

The MTCR technology is much like that of the NSG, in that because of the threat, more scrutiny in the transfer and movement of this technology occurs. Also, because both sides of the dual-use relationship remain in missile technology, it is not hard to distinguish for what the equipment is being used. Therefore, much like the NSG, this technology is not mobile.

The dual-use and conventional weapons that the WA controls provides for the most mobility among the four regimes. By its nature of being both dual-use, and conventional, as well as less threatening than the other regimes technologies, the WA is

dealing with highly mobile technology that can easily make its way around the world as evidenced by the lack of oversight mentioned in the GAO report on China's semiconductor industry. Even with export controls in place, it seems like the more mobile the production of a technology, the less control a regime may have in reducing proliferation.

5. State Interest in the Regime, Relative to their Other Interests

This variable describes a very important part of international regimes, which is how interested a state is in cooperating in these forums. The measurement of interest relative to their other interests considers the complexity of foreign politics in an anarchic world. Mitigation of such anarchy can be done through these multilateral regimes. Although many types of multilateral regimes cover several topics including economics, these export control regimes specifically focus on security. Robert Jervis describes security regimes as being not only a concept of norms and expectations, but also a form of cooperation more than security one's own self-interest.[103] In the case of WMD export control regimes, the fact that they even sit at the table and participate in the regime itself shows some level of interest in the end state of the regime. One thing that may come to bear in this section is that financial interest may play a larger role than the security of this technology. This section explains state interest based on the technology in question while considering some of the previous variables from this chapter.

As mentioned in the technology threat section of this chapter, the NSG deals with very dangerous technology, which is perhaps one of the driving factors of state interest in the NSG. The participation has grown from its original seven nuclear suppliers to the 46 members it has today, including some non-supplier states.[104] The organization as a whole has its own issues when it comes to transparency; however, because of the danger of this technology, it would appear that state interest remains in the regime and not in attempting to promote its own self-interest.

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[103] Robert Jervis, "Security Regimes," in *International Regimes*, ed. Stephen D. Krasner, 8th ed. (Ithaca, NY: Cornell University Press, 1982), 173.

[104] McGoldrick, "The Road Ahead for Export Controls: Challenges for the Nuclear Suppliers Group," 30–36.

State interest in the AG lies in the fact that the technology is dangerous, but not as much political fervor exists in attempting to export it. In fact, the harmonization of the export control efforts among the countries shows that great interest occurs in attempting to curb the proliferation of this technology.

The MTCR is unique in that the threat is still great, but state interest is somewhat lacking due to the "north-south" argument when it comes to this technology. Those states that are members of the regime have an interest in securing missile technology, yet those who are not members believe they are being restricted from this technology. As the MTCR members do routinely engage on the matter of missile technology proliferation, it would appear that state interest does occur in restricting this technology.

The regime that appears to have the hardest job securing interest in its effort is the WA. As the threat is low, and the dual-use relationship is high, the WA must deal with the market of dual-use products that may or may not be enforced in the individual countries. The example of China's semiconductor industry plagues the WA, with the GAO pointing fingers right at the regime for not doing enough to stop the export, which shows that more state interest exists in enhancing a technical export sector over the threat of computer chip exports.

6. Capability for Capacity Building

The consensus-based nature of the current export control regimes infers that the members will implement the decisions made to facilitate international export control. The inception of each regime lacked the ability to increase the capacity of a participating state in enhancing export controls with respect to each of the technologies. Instead, the members would harmonize or confer on domestic export control efforts to garner an understanding. If one nation was lacking in its ability to implement and enforce export control lists established by the consensus, it was ostracized among the other members. This section defines what capacity building is, and also outlines previous efforts in nonproliferation capacity building. It also explains that although no intention for outright

capacity building existed among the members in each regime, an evolution of this effort has occurred with help from the United Nations and other non-governmental organizations.

To begin with, capacity building in the context of this thesis involves the ability for the regime to lend help to those countries struggling with the ability to enforce the export control efforts agreed upon by the regime. Historically, other efforts in capacity building have occurred concerning nonproliferation. The European Commission began developing capacity-building efforts for nuclear nonproliferation since the 1990s, which evolved into the European Union's WMD safeguard program still in place to this day.[105] The International Atomic Energy Agency also provides many capacity-building missions to developing states when it comes to safeguarding nuclear technology, which is done through programs, such as the Integrated Nuclear Infrastructure Review (INIR) Mission and the IAEA Nuclear Knowledge Management (NKM). As the name suggests, the INIR missions are meant to review what infrastructure is in place in nuclear countries to best ascertain the deficiencies that need rectification.[106] Although not an all-encompassing capacity building effort, the INIR provides insight that can be coupled with efforts, such as the NKM. The NKM provides the knowhow both to countries seeking nuclear technology, and those with stagnant programs that require revitalization through training its managers.[107]

More recently, the effort of the Proliferation Security Initiative (PSI) has increased the capacity to interdict the flow of shipments thought to have WMD material. According to Andrew Winner, the PSI goes beyond exercises and simulations to toughen deterrence; it also helps create a legal framework to allow boarding of vessels under

[105] Kamil Zwolski, "The External Dimension of the EU's Non-Proliferation Policy: Overcoming Inter-Institutional Competition," *European Foreign Affairs Review* 16, no. 3 (August 2011): 325–340.

[106] International Atomic Energy Agency, *Integrated Nuclear Infrastructure Review Missions: Guidance on Preparing and Conducting INIR Missions* (Vienna, Austria: IAEA, 2009).

[107] International Atomic Energy Agency, "About NKM—IAEA Nuclear Knowledge Management," (n.d.), http://www.iaea.org/nuclearenergy/nuclearknowledge/AboutNKM.html.

convenience-state flagged ships.[108] This initiative is one of few instances in which the international legal aspect in fighting WMDs has spawned a global effort.

Although efforts in capacity building have occurred regarding nonproliferation, the big push for the increase in capacity building that includes export control regimes came in the wake of the September 11, 2001 attacks. President George W. Bush called on the UN to pass a resolution to close the gap in proliferation of WMDs to non-state actors. The UNSC Resolution 1540 took shape as a way to criminalize proliferation and universalize export control standards.[109] The resolution also called for the creation of effective laws to control WMD-related transfers, essentially attempting to strengthen what was considered weak export control efforts among the regimes. Most importantly, it called for each state to develop a stronger capacity to control these exports,[110] which was obviously seen as difficult to implement, especially due to the fact that the 15 members of the Security Council were the ones voting on it, not the General Assembly. From this resolution came some assistance to those who requested capacity building. Currently, the United States, the Group of Eight (G8) and the European Union (EU) are the major players in providing assistance for capacity building in various countries that need it. One group within the United States is the CITS, which focuses on research, training and outreach in an attempt to strengthen nonproliferation efforts. Although the group has been around since the late 1980s, its response to Resolution 1540 has increased its outreach and training programs, and created special courses, such as the International Export Control Academy held in Athens, GA.[111]

Although not specifically an export control regime, the UN proposed Arms Trade Treaty has a provision to implement a capacity-building mechanism within the organization. This effort is meant to regulate conventional arms trade practices, while at the same time, provide for the enforcement capacity. Perhaps this effort is more unique

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[108] Andrew C. Winner, "The Proliferation Security Initiative: The New Face of Interdiction," *The Washington Quarterly* 28, no. 2 (April 2005): 129–143.

[109] Jones, "Resolution 1540: Universalizing Export Control Standards?" 18–22.

[110] Ibid.

[111] Center for International Trade and Security, "Strategic Trade Control."

than the other efforts because of the vast array of possible supplier states relative to the more dangerous WMD technologies. This effort specifically outlines training in the various fields to enhance laws, regulations, policies and administrative procedures when it comes to arms trade.[112] The efforts put forth in response to UNSCR 1540 and the intentions of the Arms Trade Treaty provide the ability for capacity building that is absent from the current export control regimes. While these regimes remain informal, intervention by the UN allows for enhancement of the current export control efforts, while also holding more supplier states accountable for their own export control.

D. CONCLUSION

This chapter served as a base line to determine whether the variables presented played a role in the success or failure of each of these existing regimes. In the history section of this chapter, each regime was found either to be successful or not. Although often challenged, the NSG has technically been successful, because the members of the regime have not allowed proliferation of materials or equipment to those who did not already possess them. The AG has also been successful in limiting the transfer of equipment used in the large-scale production of chemical or biological weapons. The success of the MTCR is mixed. It was able to limit the spread of the technology and dissuade some countries from developing missile technology, but failed to reduce the ability for Iran, Israel, Pakistan and North Korea of both acquiring and testing medium range missiles. Finally, the WA has shown its weakness in being able to limit the spread of technologies based on member states willing to undercut others to continue to sell dual-use material.

The remainder of the chapter examined the regimes through the lens of six variables to determine what role the variables play in the success or failure of the regimes, while also highlighting which variables are most important. The next chapter takes these same variables and exercises them against what would be a new export control regime to control IED making materials. Table 1 is a summary of the variables presented in this chapter.

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[112] Oxfam, *National Implementation of the Proposed Arms Trade Treaty: A Practical Guide*.

	NSG (Nuclear)	AG (Chem/Bio)	MTCR (Missile Tech)	WA (Dual-use and Conventional weapons	Importance [113]
Dual-use Relationship	Not Close	Close	Not Close	Close	🡻
Transparency w/in regime management	Some transparency	Transparency	Transparency	Some Transparency	🡻
Threat of technology	High Threat	High Threat	High Threat	Low Threat	🡹🡹
Mobility of production	Not Mobile	Some Mobility	Not Mobile	Mobile	🡹
State interest	Yes	Yes	Yes	Some	🡹🡹
Capability for capacity building	In Progress	In Progress	In Progress	In Progress	🡺
Success (DV)	Yes	Yes	Somewhat	No	

Table 1. Summary of Findings for Existing MERCs

By analyzing the application of these variables, it appears that three of the variables correlate to overall regime success. The first factor is the mobility of technology production. As mentioned earlier, the significance of this variable is quite important because the success of a regime is based on the limitation of the spread of the technology in the first place. From these findings, it shows the technology that falls under the WA is quite mobile. According to the GAO report on nonproliferation, the growing supply of sensitive items, as well as the globalization of production means, makes it difficult for the regimes to keep control lists up to date, as well as control the wide availability of the technology outside of the member countries.[114] In the same factor findings, the NSG and

[113] Based on the correlation between the dependent variable (DV) and independent variable (IV). Those IV present in successful regimes are given an up arrow (🡹), while those with no real correlation are given a down arrow (🡻). The variable of capability for capacity building is inconclusive and is given a neutral arrow (🡺). The corresponding level of importance is given multiple arrows (🡹🡹).

[114] U.S. Government Accountability Office, *Nonproliferation: Strategy Needed to Strengthen Multilateral Export Control Regimes.*

MTCR show that they do not have the same mobility of production. The findings for the AG shows that the technology used for large-scale productions of chemical and biological material is not mobile, but smaller-scale versions are, which leads to some mobility for the AG.

The second and third variables appear to correlate, while also adding to success or failure of the regime. The threat of the technology and state interest show that those regimes that control higher threat technologies, as well garner more state interest, appear to be more successful. Nuclear, chemical, biological and missile technology remains a greater threat than those smaller dual-use technologies that the WA controls, which provides greater state interests in the regimes, relative to their other interests. Members of the NSG, AG and MTCR deal with dangerous technology, which provides a greater threat when proliferated that sparks state interests, if not for the collective security of the group, then for its own security.

Finally, the capability for capacity building has not been a lasting legacy of these regimes; however, new international efforts by the UN have increased the ability for states to enhance their enforcement efforts. Although little history exists about this variable, it remains important for future analysis of security regimes because it brings to light the abilities and shortfalls of members and nonmember states of each regime and what can be done to increase enforcement of supplier states. By providing this capability, the efforts of existing and future regimes will be enhanced.

Based on this chapter, it shows that those three variables will be instrumental in determining the feasibility of establishing a new export control regime to control IED making materials. Each of these three variables correlates to the success or challenge that existing regimes face. It also stands to highlight the two main points of technology export control, the technology itself and the willingness for states to control its flow.

This chapter was able compare the perceived success of each of the existing regimes with the variables presented. These findings are continued in the next chapter to determine the feasibility of a new export control regime, and where its focus on success should be.

IV. EXAMINING THE FEASIBILITY OF AN IED EXPORT CONTROL REGIME

A. INTRODUCTION

The previous chapters have explained the history and significance of the IED threat while also examining what makes the existing principle export control regimes successful. The effectiveness of the existing regimes is based on the variables presented in Chapters I and III, and shows how both the technology in question, as well as the organization, play key roles in the effectiveness of these voluntary export control efforts. While little evidence exists as to the existence of a similar regime for low technology items, this chapter examines the likelihood of establishing a regime for this issue area based on the six variables utilizing the literature on the counter IED effort and reports on the technology. The organization of this chapter begins with the introduction, and continues by being divided into sections for each of the six variables. Finally, it concludes with a summary of the findings from each of the variables, and measures the feasibility of an export control regime for IED-making materials.

B. SIX VARIABLES TO MEASURE EXPORT CONTROL REGIMES

This section reviews the feasibility of an IED export control regime based on three technologies. The first is AN, which is used as the main charge for most IEDs. The second is the DTMF board, which is used as a triggering system for IEDs. The last technology is question is the PIR sensor, which is also used as a triggering system. These technologies would be the initial focus for a possible export control regime. This section evaluates this regime through the following six variables.

- Dual-use relationship of the technology
- Transparency within the process of regime management
- Threat of the technology
- Mobility of the technology production
- State interest in the regime, relative to other interests
- Capability for capacity building

1. Dual-Use Relationship

IEDs are a unique weapon. They can be constructed from conventional munitions that have been left as explosive remnants of war (ERW) held in caches from wars past. The early period of the Iraq war presented an opportunity for insurgents to retrieve Iraqi stockpiles left largely unguarded after the overthrow of the regime.[115] Around the same time, insurgents and Taliban militants used caches of landmines and projectiles left over from the Afghanistan invasion in the 1980s to create IEDs in the early part of the war.

Once these stockpiles dried up, bomb makers turned to a well-known method of utilizing nitrogen-based fertilizer as a main charge, much like the bomb that detonated in downtown Oklahoma City. Although the use of AN as a chemical precursor for explosives has continued since the late 1950s, recent efforts have led the United States and partner nations in the South Asia region to deem AN as a dual-use item that needs to be controlled. This effort is being conducted by a U.S. led international interagency task force known as Operation Global Shield, which is an effort to slow the movement of AN across borders, both throughout the region, as well as throughout the world.[116] However, the issue that arises when talking about such an item with a dual-use relationship is the economic impact it could create when controlling it. AN's original use is as a farming fertilizer, and areas in Afghanistan that require fertilizers to enhance the economy of the poor tribal regions need fertilizer to help grow the economy and stabilize the region. Several efforts within the country have attempted to ban its sale, and even reduce the nitrate levels to reduce the lethality in the event it was to be used as an explosive. Since it is used so readily as an explosive, as well as an agricultural tool, AN presents itself as having a close dual-use relationship.

The triggering systems used in IEDs tend to range anywhere from rudimentary victim operated pressure plates that simulate a homemade land mine, to the sophisticated radio controlled devices used in Iraq and Afghanistan. Both DTMF boards and PIR

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[115] Montgomery Mcfate, "Iraq: The Social Context of IEDs," *Military Review* (May–June 2005): 37–40.

[116] Subcommittee on Near Eastern and South and Central Asian Affairs, *Jamming the IED Assembly Line: Impeding the Flow of Ammonium Nitrate into South and Central Asia*.

sensors are commercially available items that have their roots in communications and security systems, respectfully. Since its use began in the early parts of the Iraq war, DTMF technology has been the focus of electronic warfare countermeasures. Yet its acquisition can be easily done through electronic stores or even through the Internet. CDR John Moulton, a senior Navy Explosive Ordnance Disposal (EOD) Officer, explains that beyond the dual-use nature of the actual components, even radio frequencies do not stand out among the sea of transmissions from various benign devices.[117] He continues to describe how legitimate electronics shops can provide and even order whatever electronic component the bomb maker needs, including items such as DTMF and PIR sensors.[118]

Both the availability, as well as its employment, shows that these three items have a very close dual use relationship. They all started as commercially used items that have transformed themselves into weapons and weapon components. Also, because they are commercial items, they are easily acquirable through many vendors.

2. Transparency within the Process of Regime Management

The informal nature of the existing regimes shows that transparency is key in ensuring cooperation among the various members. Regime management provides a forum in which all member nations can openly talk about export control efforts within their own individual states. In addition, the states must implement the agreed upon export control laws that were decided upon by consensus.

Concerning a control list for IED making materials, variables, such as state interest and threat of the technology, greatly affect whether the management of the regime is going to be transparent in its decisions. As this regime does not yet exist, there is little to measure concerning this variable. Instead, examples from the existing regimes could add to transparency when establishing this regime that would include

[117] John Moulton, "Rethinking IED Strategies: From Iraq to Afghanistan," *Military Review* 89, no. 4 (July/August, 2009): 26–3, http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=RETHINKING+IED+STRATEGIES%253A+From+Iraq+to+Afghanistan&title=Military+Review&issn=0026-4148&date=2009-07-01&volume=89&issue=4&spage=26&au=Moulton%252C+John.

[118] Ibid.

organizational techniques that encourage information sharing, timeliness of reporting, and continuing a consensus-based format for management of the regime. Also required would be enforcement of a "no-undercut" rule to reduce the ability for buyers to "shop around."

3. Threat of the Technology

A driving factor for state interest and even transparency among the management of the regime involves how threatening the technology is. As shown in the previous chapter, nuclear, chemical, biological and missile technology remains at the forefront of continued international effort to slow proliferation, as these technologies remain high threat. IED technology remains threatening in certain settings, for example Iraq and Afghanistan, and as a capability for terrorist actions in other parts of the world. Iraq and Afghanistan have provided two fronts in a decade-long IED campaign set by insurgents against coalition forces. The threat is also spreading as well, with terrorist threats of using IEDs in London, the United States, and various Southeast Asia and South American countries.

The threat of IEDs can come in many sizes. The power that large amounts of AN can produce equals that of commercially military grade explosives. The Oklahoma City bombing killed over 160 people while causing half of the nine story building to collapse, utilizing AN and fuel oil packed in 55 gallon drums lined on the inside of a Ryder truck.[119] Afghanistan has also shown what a consistent IED campaign using AN as the main charge can do. In 2010, the Pentagon reported that 80 percent of the IEDs in Afghanistan are made with AN.[120]

The threat of the explosives is coupled with the threat of the triggering mechanisms as well. In the early stages of the Iraq war, insurgents were using radio frequency mechanisms to set off the devices from a safe distance. This threat was mitigated as coalition forces, through JIEDDO led efforts, began a counter-IED campaign

[119] David Hoffman, *The Oklahoma City Bombing and the Politics of Terror* (Port Townsend, WA: Feral House, Constitution Society, 1998).

[120] Subcommittee on Near Eastern and South and Central Asian Affairs, *Jamming the IED Assembly Line: Impeding the Flow of Ammonium Nitrate into South and Central Asia*.

involving electronic jamming of frequencies to protect convoys. Now, electronic systems to jam radio signals have evolved to the point of man-portable devices to protect dismounted soldiers in Afghanistan.[121]

Although an effort has occurred to counter the threat of IEDs using DTMF technology, victim operated triggering devices still lurk on the battlefield. Pressure plate systems plague foot soldiers and marines, while electronic devices, such as the PIR sensor, continue to be a threat to truck convoys. In Iraq, the systems tended to be coupled with an explosively formed penetrator that could damage even the most armored of trucks.[122]

The threat of IEDs tends to be smaller in nature when compared to NBC devices and delivery systems, but the threat remains for soldiers and civilians alike. The continued threat spans beyond the borders of Iraq and Afghanistan, where over 300 IED incidents occur every month. The lessons emerging from these two battlefields continue to increase the bomb-making capability of insurgents and terrorist organizations worldwide. Although the threat is not as great, IEDs are a more readily used weapon, and therefore, still remain a threat.

4. Mobility of Technology Production

As presented in the previous chapter, a link tends to occur between the dual-use relationship and the mobility of technology production in determining the effectiveness of a regime. WMD technologies that had a close dual-use relationship showed that because of that relationship, it was easy to move production, and even the materials themselves. The three items in this chapter began as commercially available items, and as such, showed that this technology is highly mobile.

The production of AN can be done in an industrial setting, by mixing both nitric acid and ammonia, and can be distributed in either liquid or solid form.[123] Many bomb

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[121] Rita Boland, "Dialing Up the Bandwidth Battle Against IEDs," *Signal* 65, no. 8 (April 2011): 25–27.

[122] Zorpette, "Countering IEDs," 26–35.

[123] Environmental Protection Agency, *Inorganic Chemical Industry: Ammonium Nitrate* (Washington, DC: EPA, 1993).

makers tend to utilize the solid form, by taking the prills manufactured for commercial purposes, and grinding it down to purify the mixture beyond the industry standard. The initial production of the solid prills usually remains in an industrial setting; the purification process that makes the chemical explosive-grade is often done in any location. The United States is continuing efforts to ban of production of AN in Afghanistan, in addition to pressing for the ban of production in Pakistan as well.[124] However, it continues to be a consistent problem due to Afghanistan's porous borders that allow the chemical precursors to enter.

Both DTMF and PIR technologies are often produced in mass quantities as well, as it remains a common technological item. The mobility of the production is often limited only by the ability of factories to produce the product as cheap as possible. DTMF technology started in the United States in the early 1960s, but production quickly moved to areas in which the boards could be produced as cheap as possible. Open source research shows that the majority of these items are manufactured in Mainland China and India, with other factories in Taiwan, Hong Kong, and even the United States.[125]

The civilian uses of these items show that its production is quite mobile, and is often only limited by the efficiency in which it can be produced. Companies continue to look for cheaper methods to manufacture technological material, and move entire factories to accomplish this effort. JIEDDO also sees the threat of the mobility of technology, as it released its strategic vision in 2012 that names globalization of legally produced materials as a threat to the IED fight.[126] As a result, it makes it difficult to pinpoint the source of the material, and also creates a greater economic burden than the production of dual-use WMD materials. Although the material production does not move often, it has the capacity to move.

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[124] "US Seeks to Ban Ammonium Nitrate Production in Pak," *The Indian Express*," July 4, 2011, http://www.indianexpress.com/news/us-seeks-to-ban-ammonium-nitrate-production-in-pak/812549/.

[125] The Find, "Dtmf Board | Shop Dtmf Board Sales & Prices at TheFind," http://www.thefind.com/electronics/info-dtmf-board; Global Sources, "Passive Infrared Detector Manufacturers & Suppliers."

[126] Joint IED Defeat Organization, *2012–2016 JIEDDO Counter-IED Strategic Plan Released*.

5. State Interest in the Regime, Relative to their Other Interests

In the chapter that focuses on WMD export control, state interest relies heavily on the threat of the technology, and how willing states are to abide by the export control measures agreed upon by the regime. WMD technology presents higher threats that pique the interest of both supplier and non-supplier states that wish to control the items. Within the context of this chapter, state interest involves how directly affected a state is by IEDs and the listed IED material, and how willing it is to abide by the export control efforts. The author believes that this factor is important in determining whether a state would be interested in abiding by informal rules to reduce the flow of low technology items used to make IEDs.

Currently, the center of international focus on the counter-IED effort is in the south Asia region, namely Afghanistan. The use of IEDs in Afghanistan has increased since 2009, when coalition efforts to defeat the insurgency increased as well. Previously, Iraq seemed to be the center of attention for the IED fight, with insurgents attempting to gain the upper hand on the U.S. countermeasure technology. However, the IED threat is growing and affecting more countries. Senator Robert Casey, the U.S. legislator calling for more action to stop the flow of IED materials into Afghanistan, claims that it is affecting the populations of the region as well. According to his 2010 statistics, up to nine percent of the IED actions in Pakistan are directly aimed at schools and populations, while 28 percent were aimed at security forces.[127] However, the threat and affect of IEDs spans beyond the borders of Afghanistan and Pakistan.

The current global effort to stop the flow of AN utilizing border security and other interagency efforts shows the worldwide threat of the explosive precursor. Although the report on Operation Global Shield presents the threat mainly to the south Asia region, other IED events utilizing AN have occurred in the Philippines, countries in South

[127] Bob Casey, *Casey Leads Anti-IED Effort* (Washington, DC: Targeted News Source, 2011).

America, London, and even the United States over the last 20 years.[128] The United States continues to remain interested in controlling AN, both globally through Operation Global Shield, as well as domestically through the DHS' Ammonium Nitrate Security Program. This domestic program comes in response to the events during the Oklahoma City bombing, as well as the current global threat of AN IED devices.[129]

Although IED events worldwide remain a concern, many of the statistics for the triggering mechanisms are not published. DTMF and PIR triggering devices remains a concern on the battlefield to those states directly affected by the devices, which however, is limited to those of the NATO Coalition currently fighting in Afghanistan. These low technology devices continue to present a threat to those states involved in the war, and those few instances beyond the battlefield, but the threat does not seem to permeate past that point.

Based on the findings from the previous chapter, the interest that a state has in a regime relative to its other interests lies in how threatened it is by the technology. In the case of WMDs, states prioritize their interest based on the technology. In the case of IED technology, the threat only affects those NATO countries that have been directly affected by the continuous IED campaign, as well as a few terrorist victims' states. For a voluntary regime, such as the one being proposed, the states must have interest in the regime over their own interests for a regime to function. The current principle regimes rely heavily on the efforts of those supplier states to control the flow of the technology. For a regime that focuses on low technology items, states, such as China and India, would have to agree to abide by export control on low technology items when their own state interest may be focused more on the economic impact rather than the worldwide threat.

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[128] The University of Maryland's National Consortium for the Study of Terrorism and Response to Terrorism (START) has compiled a terrorist-event database that presents an excellent comprehensive look at global IED events. For more on this see: START, "Home-START-National Consortium for the Study of Terrorism and Responses to Terrorism," (n.d.), http://www.start.umd.edu/start/; Froilan Gallardo and Ellen Nakashima, "Regional Terror Group Suspected in Philippine Bombing; Police Say Indonesians Played Role in Deadly Explosion at Wharf; Two Filipinos are Arrested," *The Washington Post*, April 9, 2003; "Making Peruvian Democracy Bomb-Proof," *Wall Street Journal (1923—Current File)*, July 31, 1992.

[129] Andrew Seidman, "Sales of a Fertilizer May be Regulated; Homeland Security Wants to Monitor Ammonium Nitrate, Used to Make Bombs," *Los Angeles Times*, August 3, 2011.

6. Capability for Capacity Building

A level of capacity building is inherent in the current counter-IED fight. One of the main tenants of JIEDDO is to train the force, which includes partner nations, as well as U.S. entities, in seeking out bomb building networks and defeating the devices found. The previous chapter defined what capacity building is with regards to export control, as well as outlined the current efforts to build the export control capacities of member nations in addition to other supplier states concerning WMD material. While determining the feasibility of an IED export control regime, this chapter focuses on the existing capacity building that would help provide a framework needed to help the success of such a regime.

Providing the tools for supplier states to enforce the laws agreed upon by a consensus remains an important part of regime success. As the material to be controlled by this regime is both of low threat, and is easily mobile in its manufacturing base, it would be extremely difficult to track and control. The level of capacity building that the Arms Trade Treaty proposes would be required to provide the institutions and human resources to ensure the laws and regulations are both implemented and subsequently followed. In fact, the guide for implementation of the Arms Trade Treaty defines the items under their purview as including conventional dual-use goods, technologies and software.[130]

The previous chapter outlined how UNSCR 1540 and CITS capacity building efforts will be implemented to enhance the export control capability for WMD technologies; yet, it is important to realize that the technology in question is much harder to control and requires a unique effort to enhance the capacity of supplier states. The proposed ATT provides a good framework that would provide capacity-building capabilities to those nations that wish to participate.

[130] This paragraph outlines the proposed treaty and how it would fit into the IED control regime. For more on this see: Oxfam, *National Implementation of the Proposed Arms Trade Treaty: A Practical Guide.*

C. CONCLUSION

This chapter attempted to determine the feasibility of and IED export control regime based on the same variables presented in Chapter III. The basis for this regime would include three technologies determined to be the most commonly used in the current GWOT. The technologies presented were chosen because they are well-known and dangerous IED precursor materials that provide a good starting point for this regime. Table 2 presents each variable and finding for an IED export control regime.

	Importance	IED Regime	Success Prospect[131]
Dual-use Relationship	↓	Close	Small importance, negative impact.
Transparency w/in regime management	↓	Some	Small importance, negative impact
Threat of technology	↑↑	Some threat	Very large importance, ambiguous impact.
Mobility of production	↑	Very Mobile	Large importance, negative impact
State interest	↑↑	Some interest	Very large importance, ambiguous impact.
Capability for capacity building	→	Possible	Unclear importance, ambiguous impact.
Success (DV)			Negative

Table 2. Summary of Findings for IED Regime

[131] This combines the importance of the variable with the direction in which it affects the feasibility. That is, the arrow shows the direction of importance of the variable from the previous chapter (↑↓) with the findings from this chapter concerning the IED regime (negative/positive/ambiguous). Those variables that are important that does not have an ambiguous or negative impact directly relate to the negative success of the regime.

Since this regime does not yet exist, the author draws on the findings from the previous chapter and presents the most important variables that correlate to regime success. The possibility of regime success will make it more likely that a new regime that focuses on IED-making materials is feasible. The variables that correlated to regime success in the previous chapter include the threat of the technology, mobility of production, and state interest (see Table 2).

In analyzing a possible IED export control regime, it appears that once again the threat of the technology and state interest are correlated. This chapter shows that some state interest and some threat of the technology exits. In other words, a threat and state interest do occur, but it is very localized and limited in scale. The mobility of this technology is very high. As this variable has shown to be important due to the measure of success remaining the limitation of the spread of this technology, it would be a challenge for a regime to control IED-making materials to be successful.

Based on the lack of success of this regime, it would be extremely challenging to create a new regime that would control these materials, which differs from the challenges that face the WA because the established nature and history of conventional and dual-use export control dates back to the former COCOM.

To address the ability for this regime to enhance the capacity of states in the counter IED fight, it is first necessary review the current global counter-IED efforts. The ability to enhance the capacity of other states is already inherent through JIEDDOs "training the force," as well as the actions of Operation Global Shield. The previous chapter also presented the efforts of the UN through its resolution 1540, as well as other non-governmental actors attempting to enhance global export control laws. For the purposes of this regime, the Arms Trade Treaty provides a good framework for capacity building for these dual-use items.

However, the lack of a grander threat, and the lack of total state interest, cannot overcome mobility of the technology. The difficulty lies in the ability for many more items to be classified beyond just these three technologies. The improvised nature of

these devices makes it difficult to track the end use, as well as becomes an economic burden to states attempting to export these technologies. As a result, it becomes infeasible to create a completely new regime to control the export of these items.

V. CONCLUSION

A. SUMMARY AND FINDINGS

This thesis sought to determine the feasibility of a new export control regime to control the materials used to make IESs. The first few chapters focused on the history of IEDs and the current global efforts in countering them. The author then identified the gap in efforts and the scenario in which a new regime would provide help in that fight. He then proposes three items used in IEDs that would be the focus of this regime. He subsequently examined the current principle export control regimes, utilized their history of success, and then measured them against factors proposed by the literature and some deemed important to the establishment of a new regime. This review became the baseline of a new IED export control regime; in which the most important factors were drawn on to determine the success of a regime, which in turn, would lead to the feasibility of establishing this new regime.

In the third chapter on the existing regimes, the dependent variable showed that the NSG, the AG and the MTCR could claim success, while the WA was not successful. By examining these regimes concerning the factors for regime success, it was determined that threat of the technology, state interest in the regime, and the mobility of the technology are important factors in determining regime success. In each of these cases, the regimes were successful because the technology was threatening, which in turn, led to more state interest and involvement in ensuring the success of the regime. The findings also showed that the less mobile a technology is, the more it can be controlled, which is central to the idea of an export control regime that measures success based on limiting the spread of the technology in question.

These findings were then applied to the section on the feasibility of an IED export control regime. Although this regime does not exist, the variables were applied to an outline of what the regime would look like. Those variables not easily defined due to the nonexistent nature of the regime were defined more in terms of what a successful regime would look like. Drawing on the findings from the third chapter, special emphasis was placed on those three variables deemed most important.

What was found is that this regime would not be feasible. The technology that this regime would control is too commonly used in the civilian world. Although the factor of dual-use relationship was found not to be as significant as the others, it still showed that the relationship between the civilian and military use was quite close, which translates to the technology being able to move under the concealment of being a civilian technology. These findings also showed that the lack of state interest about the technology used in IEDs was very low, which translates to states not willing to become involved in such a regime. Without state interest, a regime would not function as efficiently and transparently as needed to make it successful.

B. LIMITATIONS OF FINDINGS

One limitation to these findings revolves around the measure of success used in the third chapter. Much of the literature on the existing regimes is quite critical, and those pieces that acknowledge regime success also propose reforms that would make the regimes even more successful. What can be drawn from this literature is that varying degrees of regime success can range from mildly successful to a complete blockade of all technologies on a given control list. By defining success as limiting the spread of the technology, but not necessarily stopping proliferation completely, it provides a technical definition of success to correlate with those independent variables presented in both Chapters III and IV.

A second limitation also involves the success of the regimes. Regime success in the context of the findings may not consider the pressures placed on the regimes by a state or states trying to break through. Those regimes that appear successful may not be as efficacious with the constant challenge against the export control policies agreed to by the members.

A third limitation involves the technology chosen as the items of control for this new regime. As mentioned several times, the improvised nature of the devices makes it hard to define what exactly should be controlled. Rapidly evolving technology also changes the landscape of components used in the devices. The wide variety of readily available dual-use components makes it difficult to define what an IED component is.

C. PATH FOR FUTURE RESEARCH

Future research could take these three limitations and expand on them. In the case of defining regime success, a more independent study utilizing counterfactuals could enhance the definition of regime success to correlate them better with the independent variables. The same could hold true for the second limitation. What would these regimes look like if constant pressures were placed on the regime that challenged the export control efforts? Would those regimes that appear successful still have the same levels of success? Future research could also focus on the IED control regime and increasing the materials to be controlled. More balance within the variables may be provided (i.e., more items to measure dual-use relationship, threat of the technology, etc.)

Future research could also examine how an existing regime may control these materials. Currently, the WA is the one existing regime that closely relates to the technology found in IEDs. Even if considered the weakest of the four regimes, it still provides cover for material that can be deemed dual-use, and in turn, help in the counter-IED fight.

D. POLICY IMPLICATIONS

The research question to determine the feasibility of a new export control regime for IED material was intended to bring to light the much broader policy debate of how to

add to the counter-IED fight. The current effort, as mentioned many time before, is led by a variety of U.S. agencies and groups that focus on the bomb-building network. This current focus remains on the lower end of the supply-demand spectrum (see Figure 2), while this thesis was examine how to stop the flow of the material before it even gets into the hands of the bomb builder. JIEDDO, the current lead agency, spends an average budget of over $220 million on a variety of programs and technologies to protect those on the battlefield through training and equipment that help save lives.[132] Yet, still not addressed is the supply of the material being used.

Furthermore, the finding of the infeasibility of a new regime still leaves this gap in the current counter-IED efforts. However, it is still important to recognize some focus still needs to occur on the supply-side efforts in this fight. This thesis mentioned on a few occasions Operation Global Shield, which is more of a "mid-stream" effort in controlling AN. With this model in place, perhaps the effort could be expanded beyond AN and other precursor chemicals to contemplate the electronic items that trigger IEDs. The findings of this thesis mention a select few countries that are the constant victims of IEDs; it would, therefore, be simple to concentrate on those countries concerning what comes in, rather than attempting to focus on what comes out of those supplier states.

Another issue to ponder is the considerable draw down in forces from Iraq and Afghanistan, while also dealing with looming budget cuts. Combining the efforts JIEDDO and Global Shield, along with the other outlying agencies, could create a more comprehensive effort that would combine budgets, as well as experts in the fields that each organization possesses. It may fall short of a "whole of effort approach" proposed by this thesis, but it could be the best answer for now.

E. CONCLUSION

Finally, with the two-front GWOT drawing to a close, it is necessary to focus on the global IED threat that has expanded beyond the borders of Iraq and Afghanistan. The IED is not a new weapon; it continues to evolve, especially with advances in technology.

[132] Department of the Army Procurement Programs, *Fiscal Year (FY) 2012 Budget Estimates: Joint Improvised Explosive Device Defeat Organization* (Department of the Army, 2011).

This expansion has led to over 250 IED events every month outside of these declared battlefields. Although this thesis determined it would not be feasible to control IED-making materials through an export control regime, a continued focus needs to be placed on limiting the supply of IED materials. The United States should continue to lead the way in developing new ways to combat these devices, and provide the training to other nations dealing with the threat as well. These efforts could close the gap between supply and demand, and provide a great deal of support to those global efforts already in place, which needs to continue to provide another method to combat the IED.

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LIST OF REFERENCES

Aleph America. “Aleph Passive Infrared Detectors.” (n.d.). http://www.aleph-usa.com/Aleph-Products/Passive-Infrared-Detectors.

Alibaba. “China DTMF Manufactures, Suppliers and Companies.” (n.d.). http://www.alibaba.com/countrysearch/CN/dtmf.html.

“Ammonium Nitrate (Chemical Compound).” *Britannica Online Encyclopedia.* (n.d.). http://www.britannica.com/EBchecked/topic/21045/ammonium-nitrate.

Arms Trade Treaty. “Preparatory Committee.” (n.d.). http://www.un.org/disarmament/convarms/ATTPrepCom/; Oxfam, *National Implementation of the Proposed Arms Trade Treaty: A Practical Guide*. CITS/Oxfam, 2010.

Atlas, Ronald M., and Malcom Dando. “The Dual-Use Dilemma for the Life Sciences: Perspectives, Conundrums and Global Solutions.” *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science* 4, no. 3 (2006): 276.

Australia Group. “The Australia Group.” (n.d.). http://www.australiagroup.net/en/index.html.

Beck, Michael. “Reforming the Multilateral Export Control Regimes.” *Nonproliferation Review* 7, no. 2 (2000): 91–103.

Beck, Michael, and Seema Gahlaut. “Creating a New Multilateral Export Control Regime.” *Arms Control Today* 33, no. 3 (April 2003): 12–18. http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=Creating+a+new+multilateral+export+control+regime&title=Arms+Control+Today&issn=0196-125X&date=2003-04-01&volume=33&issue=3&spage=12&au=Beck%252C+Michael%253BGahlaut%252C+Seema.

Boland, Rita. “Dialing Up the Bandwidth Battle Against IEDs.” *Signal* 65, no. 8 (April 2011): 25–27.

Burtchett, Nicole K. “Nuclear, Biological, and Chemical Weapons Regimes: Finding Success Under Limits.” PhD diss., Washington State University, 2009.

Casey, Bob. *Casey Leads Anti-IED Effort*. Washington, DC: Targeted News Source, 2011.

Center for International Trade and Security. “Strategic Trade Control.” (n.d.). http://cits.uga.edu/programs/STC.html.

"Chemical Weapons." (n.d.). http://www.fas.org/nuke/control/ag/docs/aus496.htm.

"Closing Remarks to Global Shield Seminar." *Federal Information & News Dispatch*, Inc. October 13, 2010.

Craft, Cassady B., and Suzette R. Grillot. "Transparency and the Effectiveness of Multilateral Nonproliferation Export Control Regimes: Can Wassenaar Work?" *Southeastern Political Review* 27, no. 2 (1999): 281.

Cullison, Alan, and Yaroslav Trofimov. "World News: Karzai Bans Ingredient of Taliban's Roadside Bombs." *Wall Street Journal*, January 23, 2010.

Davis, Brian S. *Program Global Shield: Detection Technology in Support of Program Global Shield*. Brussels: U.S. Immigration and Customs Enforcement, 2012.

Department of Homeland Security. "DHS | Ammonium Nitrate Security Program." (n.d.). http://www.dhs.gov/files/programs/ammonium-nitrate-security-program.shtm.

Department of the Army Procurement Programs. *Fiscal Year (FY) 2012 Budget Estimates: Joint Improvised Explosive Device Defeat Organization.* Department of the Army, 2011.

Dodd, Annabel Z. *The Essential Guide to Telecommunications*. Upper Saddle River: Prentice Hall PTR, 2002.

Environmental Protection Agency. *Inorganic Chemical Industry: Ammonium Nitrate.* Washington, DC: EPA, 1993.

Forge, John. "A Note on the Definition of 'Dual-Use'." *Science, Engineering and Ethics* 16, no. 1 (2012): 111.

Foster, J. C., Mcinnes F. R., Jack M. A., Love S., Dutton R. T., Nairn I. A., and White L. S. "An Experimental Evaluation of Preferences for Data Entry Method in Automated Telephone Services." *Behaviour & Information Technology* 17, no. 2 (March 1998): 82–92.

Gallardo, Froilan, and Ellen Nakashima. "Regional Terror Group Suspected in Philippine Bombing Police Say Indonesians Played Role in Deadly Explosion at Wharf; Two Filipinos Are Arrested." *The Washington Post*, April 9, 2003.

Gärtner, Heinz. "The Wassenaar Arrangement (WA): How it is Broken and Needs to be Fixed." *Defense & Security Analysis* 24, no. 1 (March 2008): 53.

Global Security. "Improvised Explosive Devices (IEDs) / Booby Traps." (n.d.). http://www.globalsecurity.org/military/intro/ied.htm.

Global Sources. “Passive Infrared Detector Manufacturers & Suppliers.” (n.d.). http://www.globalsources.com/manufacturers/Passive-Infrared-Detector.html; Pinhas Shpater, *Passive Infrared Motion Detection Circuit having Four Comparators*, vol. 5,886,632, 1999.

Hoffman, David. *The Oklahoma City Bombing and the Politics of Terror*. Port Townsend, WA: Feral House, 1998.

House Armed Services Committee: Subcommittee on Oversight and Investigations. *The Joint Improvised Explosive Device Defeat Organization: DoD’s Fight Against IEDs Today and Tomorrow*. Washington, DC: HASC, 2008.

International Atomic Energy Agency. “About NKM—IAEA Nuclear Knowledge Management.” (n.d.). http://www.iaea.org/nuclearenergy/nuclearknowledge/AboutNKM.html.

———. *Integrated Nuclear Infrastructure Review Missions: Guidance on Preparing and Conducting INIR Missions*. Vienna, Austria: IAEA, 2009.

International Telecommunications Union. *ITU-T Recommendation F.902: Operations and Quality of Service Human Factors*. Helsinki: International Telecommunications Union, 1995.

Jervis, Robert. “Security Regimes.” In *International Regimes*, edited by Stephen D. Krasner, 173. 8th ed. Ithaca, NY: Cornell University Press, 1982.

Joiner, Jaime A. “Dual-use Export Control Laws on Nanotechnologies.” *Nanotechnology Law and Business* (Spring 2008): 53–64.

Joint IED Defeat Organization. “Defeat the Device.” (n.d.). https://www.jieddo.dod.mil/defeat.aspx.

———. *2012–2016 JIEDDO Counter-IED Strategic Plan Released*. Washington, DC: Federal Information & News Dispatch, Inc., 2012.

Joint Improvised Explosive Device Defeat Organization. “Annual Report: 2010.” Washington, DC: JIEDDO, 2010.

Jones, Scott. “Resolution 1540: Universalizing Export Control Standards?” *Arms Control Today* 36, no. 4 (May 2006): 18–22. http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=Resolution+1540%253A+Universalizing+Export+Control+Standards%253F&title=Arms+Control+Today&issn=0196-125X&date=2006-05-01&volume=36&issue=4&spage=18&au=Jones%252C+Scott.

Keohane, Robert O. “Cooperation and International Regimes.” In *After Hegemony*, 49–64. Princeton, NJ: Princeton University Press, 1984.

Krasner, Stephen D. “Overview.” In *International Regimes*, edited by Stephen D. Krasner, 1–2. Ithaca, NY: Cornell University Press, 1983.

Latham, Andrew, and Brian Bow. “Multilateral Export Control Regimes: Bridging the North-South Divide [MERCs].” *International Journal* 53, no. 3 (Summer 1998): 465–486.

“Making Peruvian Democracy Bomb-Proof.” *Wall Street Journal (1923—Current File)*. July 31, 1992.

Makle, Denver. “Joint Multinational Training Command.” *Army* 61, no. 3 (March 2011): 72–80. http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=Joint+Multinational+Training+Command&title=Army&issn=0004-2455&date=2011-03-01&volume=61&issue=3&spage=72&au=Makle%252C+Denver.

Martin, James. “Dragon’s Claws: The Improvised Explosive Device (IED) as a Weapon of Strategic Influence.” Master’s thesis, Naval Postgraduate School, 2009.

Mcfate, Montgomery. “Iraq: The Social Context of IEDs.” *Military Review* (May–June 2005): 37–40.

McGoldrick, Fred. “The Road Ahead for Export Controls: Challenges for the Nuclear Suppliers Group.” *Arms Control Today* 41, no. 1 (January/February 2011): 30–36.

Missile Technology Control Regime. “Missile Technology Control Regime.” (n.d.). http://www.mtcr.info/english/index.html.

Mistry, Dinshaw, and Mark Smith. “Negotiating Multilateral Instruments Against Missile Proliferation.” *International Negotiation* 10, no. 3 (2005): 425–451.

Moulton, John. “Rethinking IED Strategies: From Iraq to Afghanistan.” *Military Review* 89, no. 4 (July/August, 2009): 26–3. http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=RETHINKING+IED+STRATEGIES%253A+From+Iraq+to+Afghanistan&title=Military+Review&issn=0026-4148&date=2009-07-01&volume=89&issue=4&spage=26&au=Moulton%252C+John.

Naudus, Stanley T. *System and Method for Efficiently Transporting Dual-Tone Multi-Frequency/Multiple Frequency (DTMF/MF) Tones in a Telephone Connection on a Network-Based Telephone System*, ed. 3. Com Corporation, vol. US 6,259,691 B1, 2001.

Nuclear Suppliers Group. “Home-Eng.” (n.d.). http://www.nuclearsuppliersgroup.org/Leng/default.htm.

Olson, Kyle. “Aum Shinrikyo: Once and Future Threat?” *Emerging Infectious Diseases* 5, no. 4 (1999): 513.

Rostberg, James I. “Common Chemicals as Precursors of Improvised Explosive Devices: The Challenges of Defeating Domestic Terrorism.” Master’s thesis, Naval Postgraduate School, 2005.

Seevaratnam, James I. “The Australia Group: Origins, Accomplishments, and Challenges.” *The Nonproliferation Review* 13, no. 2 (July 2006): 401–415, doi:10.1080/10736700601012227. http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=The+Australia+Group%253A+Origins%252C+Accomplishments%252C+and+Challenges&title=The+Nonproliferation+Review&issn=1073-6700&date=2006-07-01&volume=13&issue=2&spage=401&au=Seevaratnam%252C+James+I.

Seidman, Andrew. “Sales of a Fertilizer May be Regulated; Homeland Security Wants to Monitor Ammonium Nitrate, Used to Make Bombs.” *Los Angeles Times*, August 3, 2011.

Semmel, Andrew. “UN Security Council Resolution 1540: The U.S. Perspective.” *Hampton Roads International Security Quarterly*, no. 15369609 (October 15, 2004): 29–32. http://sfxhosted.exlibrisgroup.com/nps?genre=article&sid=ProQ:&atitle=UN+Security+Council+Resolution+1540%253A+The+U.S.+Perspective&title=Hampton+Roads+International+Security+Quarterly&issn=1536-9609&date=2004-10-15&volume=1&issue=&spage=29.32&au=Semmel%252C+Andrew.

Shivang G. Joshi, Holly Berkovits Cymet, Gary Kerkvliet, and Tyler Cymet. “Anthrax in America 2001–2003.” *Journal of the National Medical Association* 96, no. 3 (March 2004): 344–50.

START. “Home-START-National Consortium for the Study of Terrorism and Responses to Terrorism.” (n.d.). http://www.start.umd.edu/start/.

Subcommittee on Near Eastern and South and Central Asian Affairs. *Jamming the IED Assembly Line: Impeding the Flow of Ammonium Nitrate into South and Central Asia*. 111th Congress, 2nd sess., 2010.

“Suspected Insurgents Captured in Nangarhar.” *Targeted News Service*, August 17, 2010.

The Find. “Dtmf Board | Shop Dtmf Board Sales & Prices at The Find.” (n.d.). http://www.thefind.com/electronics/info-dtmf-board; Global Sources, “Passive Infrared Detector Manufacturers & Suppliers.”

“US Seeks to Ban Ammonium Nitrate Production in Pak.” *The Indian Express*.” July 4, 2011. http://www.indianexpress.com/news/us-seeks-to-ban-ammonium-nitrate-production-in-pak/812549/.

U.S. Department of Defense. *JTF-GTMO Information of Detainees: Information on Guantanamo Detainees*. March 4, 2005. http://www.defense.gov/news/mar2005/d20050304info.pdf.

U.S. Government Accountability Office. *Export Controls: Rapid Advances in China's Semiconductor Industry Underscore Need for Fundamental U.S. Policy Review* by Joseph A. Christoff. (GAO-02-620). Washington, DC: GPO, 2002.

———. *Nonproliferation: Strategy Needed to Strengthen Multilateral Export Control Regimes* by Joseph A. Christoff. (GAO-03-43). Washington, DC: GPO, 2002.

U.S. Library of Congress. Congressional Research Service, *Improvised Explosive Devices (IEDs) in Iraq and Afghanistan: Effects and Countermeasures*, by Clay Wilson, CRS Report RS22330. Washington, DC: Office of Congressional Information and Publishing, 2007.

Wassenaar Arrangement. "The Wassenaar Arrangement | Homepage." (n.d.). http://www.wassenaar.org/.

Wassensaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies. "Criteria_as_updated_at_the_December_2005_PLM.Pdf (Application/Pdf Object)." (n.d.). http://www.wassenaar.org/controllists/2005/Criteria_as_updated_at_the_December_2005_PLM.pdf.

Winner, Andrew C. "The Proliferation Security Initiative: The New Face of Interdiction." *The Washington Quarterly* 28, no. 2 (April 2005): 129–143.

Wolfsthal, Jon B. "Nuclear Suppliers Group Agrees on 'Dual-use' Export Controls." *Arms Control Today* 22, no. 3 (April 1992): 19.

Zorpette, Glenn. "Countering IEDs." *IEEE Spectrum*, September 2008, 26–35.

Zwolski, Kamil. "The External Dimension of the EU's Non-Proliferation Policy: Overcoming Inter-Institutional Competition." *European Foreign Affairs Review* 16, no. 3 (August 2011): 325–340.

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